Technology Review

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SEEKING A RADICALLY NEW ELECTRONICS

The quest to exploit "quantum effects" in structures that approach the size of large molecules.

ALSO:

KERALA, INDIA: ECONOMIC PROGRESS WITHOUT GROWTH
PAGE 42

HOW PATENTS COULD RUIN THE SOFTWARE INDUSTRY
PAGE 52

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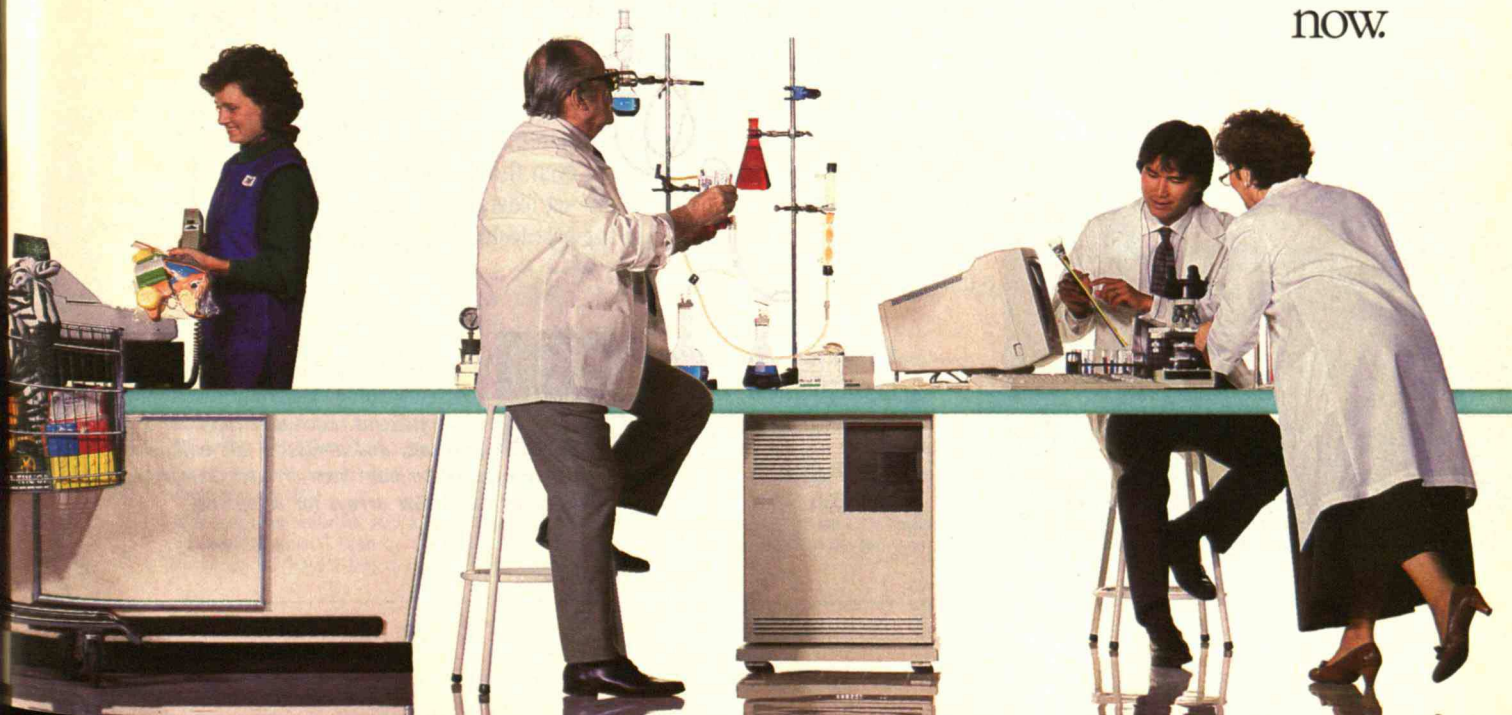
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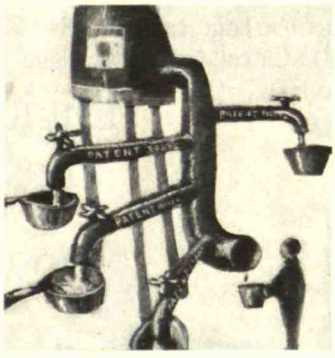
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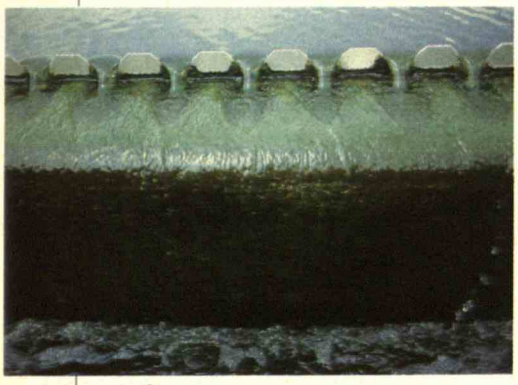
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The U.S. Patent and Trademark Office is awarding exclusive rights to thousands of programming processes ranging from machine instructions to features of the user interface. The independent software entrepreneur may all but disappear and the vitality of the industry is at stake--as is the future of computer-mediated expression.



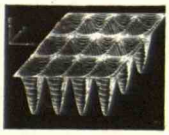
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BY DONALD F. HARLEMAN

Congress has ordered coastal communities to adopt an expensive form of sewage treatment even though newer alternatives are more effective. The lesson: set federal cleanup standards and let each community chose the best technology to meet them.

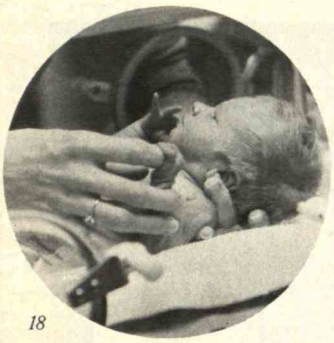
COVER
Illustration by Stephen Elston

Design by Kathleen Sayre



The cover is based on a computer printout representing "quantum wells" in a semiconductor. Each well can hold a few electrons, and arrays of 200 million such wells per square centimeter have been created. Researchers hope someday to use similar arrays for computing.

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Children and Investment

POLAND'S dissatisfaction with its backward technology surely underlies its eagerness to adopt free markets—the coal used for heating in Warsaw fouls the air with soot as if it were Dickens' London. Poles acknowledge that the discipline of the market will bring unemployment and run up costs of food, housing, and other necessities as price controls are lifted and weak firms allowed to fail. But they hope the free market will encourage investment in new enterprises to make the economy grow. This approach is seen globally—in Eastern Europe, China, Latin America, Africa, and elsewhere—as the route to prosperity. During the 1980s the International Monetary Fund (IMF) and World Bank have imposed similar free-market "economic adjustment" programs on Third World debtors.

The State of the World's Children 1990 by the United Nations Children's Fund (UNICEF) suggests a fundamentally different perspective on the world economy. During the 1980s, free-market programs and reduced government spending contributed to a direct and brutal disinvestment in the lives of children. As incomes fell 10 percent in most of Latin America and over 20 percent in sub-Saharan Africa, there was nothing to stand in the way of malnourishment for the poorest. Per capita health-care spending declined in three-quarters of the Latin American and African countries, while two-thirds of what we call "developing" nations reduced their budgets for education. Even in the United States, where the economy grew substantially, the proportion of children living below the poverty line increased 36 percent. In New York, the financial capital of the world, 40 percent of the children live in poverty.

Such disinvestment is all but irreversible. As Richard Jolly, deputy executive director of UNICEF, told a congressional committee: "Investment in human capital in the form of nutrition, basic education, and health cannot be postponed: it either takes place at an appropriate age when the need is present—or it does not. For the young child, there is no second chance. The underemphasized tragedy of the disinvestment in human capital in the 1980s is that the results will be carried forward in stunted bodies and deficient educations well into the twenty-first century."

Which should have the first call on social investment: the minds and bodies of children or new machinery? To ask the question is to answer it. A generation's impact on society far outlasts any physical capital. German industry was destroyed after World War II, but the nation was able to build on its long tradition of excellent education.

Means Versus Ends

The free-market approach that seeks economic growth often forgets that this is not an end in itself but merely a means to the goal of alleviating poverty. While most economists are concerned with per capita income, inflation, and such data, UNICEF measures progress by directly counting the number of children out of each thousand who never reach their fifth birthday. This tells a great deal about factors such as the availability of food and clean water, the state of a country's health-care system, the overall safety of the environment, and mothers' health and knowledge about health. *The State of the World's Children* ranks nations from Afghanistan, where 30 percent of children never reach five years old, to Finland and Sweden, where only 0.7 percent are dead by that age.

By this ranking, free markets do not do very well, as Vicente Navarro of the Johns Hopkins School of Hygiene and Public Health has pointed out. Compare India and China, two large, ethnically diverse Asian nations, one with a free market, the other a planned economy. China had a higher under-five mortality rate than India in 1945, according to earlier UNICEF reports. By 1960 the two countries had switched places, China's rate falling to 202 per thousand while India's was 282. Today, though their per capita incomes are nearly the same, China has an under-five mortality rate of 43, while India's is 149. China's adult literacy rate is 69 percent, while India's is 43 percent, and China's life expectancy is 70, while India's is 58. ("The Kerala Experiment," page 42, describes what one relatively poor Indian state has been able to achieve through efforts to redistribute wealth rather than promote growth.)

The same sort of relationship holds in Latin America. The planned economy of Cuba has the lowest under-five mortality rate, 18 out of 1,000, as well as 96 percent adult literacy and an expected life span of 74 years. By contrast, Honduras and El Salvador have under-five mortality rates of 107 and 84. Large, industrialized economies have comparable rates—Brazil's is 85 and Mexico's 68. In Europe, under-five mortality rates in the Eastern bloc are slightly worse than those in the West. For example, West Germany's is only 10, while East Germany's is 12. However, the East German rate is slightly better than the U.S. rate of 13.

The socialist countries' lack of basic liberties such as freedom of speech and travel is indefensible, but UNICEF's figures suggest that they have done relatively well in defeating the worst human economic misery. This is not surprising: for all its clumsiness, central planning has aimed to do just that. Eastern Europe's technological backwardness demonstrates that the invisible hand of the market has an undeniable efficiency. But human progress ultimately requires conscious planning. The world is likely to need such planning as it faces issues ranging from children's health to the global environment. ■

JONATHAN SCHLEFER

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Letters



THE PRODUCTIVITY RIDDLE

"Making Sense of the Productivity Debate: Reflections on the MIT Report" by Jonathan Schlefer (*TR August/September 1989*) is the best example of eloquent writing from an intelligent open mind I have ever seen.

I would like to add that one of the more curious things about the MIT commission is its members. That these people have been tremendously successful in their chosen fields is without question. On the other hand, if people are successful within a structure, they fit the requirements of that structure. And this means that any problem with the structure is also their own problem, which makes it hard for them to see what's really going on. But then again, the situation could have been worse—at least the commission was not made up of the heads of American industry.

JAMES P. GARIN
Atlanta, Ga.

DRAWING THE LINE IN HEALTH CARE

Here in a community of retirees, the no-win situation Arnold Relman presents in "Confronting the Crisis in Health Care" (*TR July 1989*) is particularly acute. Ironically, the longer our lives are extended by medical and surgical advances, the more health care and custodial care we need. Few of us move into our 70s without increasing dependence on the medical establishment.

A question then arises: In these days of parts replacement and other surgical techniques requiring a roomful of specialists, are we oldsters getting too large a share of the health-care resources, especially when society is paying the bill through insurance or subsidy? Perhaps one solution would be to establish a health-care quota for each of us at—say—age 65. For example, we might each be assigned 2,000 health-care units to be applied over the rest of our lifetime for medical, surgical, and skilled nursing care. A simple checkup might cost 20 units; a major parts-replacement operation 1,000 units. When one's quota was used up, one could expect nothing beyond the simple homestyle care of past generations. Such a system surely would be less drastic than it sounds, because both patient and physician would probably develop a new conservatism as the end of the quota approached.

E. SCOTT PATTISON
Dunedin, Fla.

The interview with Arnold Relman is disappointing. Not only does Dr. Relman dispute well-known facts and contradict himself, but he unreservedly advocates socialized medicine.

First, we know beyond doubt that technology makes every other area of our lives easier, richer, and more productive, so why should technology make medicine less efficient? Contrary to what Dr. Relman says, technology has not been the engine of cost escalation in medicine. Whether rich or poor, patients can and do make appropriate medical choices based on both medical knowledge and economic facts. Grants to consumers (or "welfare") are inflationary because they distort these facts. It is thanks to "first-dollar coverage" (very small deductibles and co-payments), as provided by Medicare and employee benefit plans, that the rate of increase of medical prices—those of the new technology, in particular—exceeds that of all other consumer prices. It will continue to do so for as long as such politically generated infusions of funds exist.

Second, the centralization Dr. Relman advocates inevitably means bureaucracy and waste, because it takes decision-making powers away from the persons who know the most relevant particulars. Even the best physician is

bound to make errors as a manager and planner of other physicians' work. Dr. Relman would have us believe that we could eliminate waste by decree—just wish it away—even as we further centralize and depersonalize medical care. This is absurd.

Third, standards are the hallmark of the bureaucratic way of doing things, and they inevitably stymie good medical care and slow down progress. Yet Dr. Relman—even as he decries the ignorance the medical textbooks contain—calls for more and tighter standards of care. It should be plain that such standards are nothing but imposed ignorance, unlike voluntary conventions of language or notation.

Dr. Relman repeatedly declares against market medicine, ignoring that only the market can establish a relevant price system. If we go his way (and we certainly are), we can expect only higher prices, less freedom, and worse medicine.

GEORGE YOSSIF
Birmingham, Ala.

DISSENT IN BRITAIN

Bennett Harrison's fine assessment of Britain's industrial problems (*"Fail Britannia?" TR October 1989*) neglected to mention the attitude of the country's factory and shop workers. Britain's decade-long rise of murderous soccer-game riots is occasionally reported in the U.S. media. But the escalation of civil disobedience, assaults, and murders in the streets and workplace generally is not, so many of us are unaware of how restive the working class has become.

There are large numbers of Irish Catholics in the workforce of Liverpool and other industrial centers. Many are outraged by the torture, killings, and miscarriages of justice suffered by Irish Catholics as Prime Minister Margaret Thatcher's forces fight "Irish Republican Army suspects." These workers cite, among other things, the Gibralter killings, in which a death squad shot three such suspects in the back with 50 rounds of ammunition, and the "bloody



Sunday massacre," in which British troops fired into a civil rights procession, killing 13 unarmed civilians. Harrison's conclusion that our industrial prospects are similar to Britain's does not account for any of this.

ROBERT F. McALEVY III
Hoboken, N.J.

COMING TO TERMS WITH CHERNOBYL

"Chernobyl: What Really Happened" by William Sweet (*TR July 1989*) is revealing and disturbing. What's more, the problems of the troublesome Soviet RBMK reactors may hit closer to home than we expect, since a Soviet nuclear power plant is currently under construction in Cuba at Cienfuegos. As early as 1990, the people of Florida could have a nuclear plant of Soviet-Cuban design operating only a few hundred miles offshore. And four more nuclear plants are scheduled to be built in Cuba in the ensuing decade.

J. RICHARD SHANEBROOK
Schenectady, N.Y.

Technology Review is to be congratulated on "Chernobyl: What Really Happened." In my opinion, the article makes it clear that we can deal with nuclear energy effectively if only we keep in mind the saying familiar to all MIT undergraduates: "Power is dangerous and must be handled prudently." The lessons the disaster drives home are the same ones our ancestors learned in the nineteenth century when railroad bridges regularly fell down and steamboats regularly exploded.

I also admired the article's stunning photographs from the Soviet government. But I can't say the same for the rest

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of the artwork—specifically, the diagrams. First of all, the drawing titled Fuel Channel (page 48) appears to show a fuel rod. And it does not show why the welds, which can barely be made out, are particularly weak or dangerous, as the author asserts. This drawing, besides being mislabeled, conveys no information. Furthermore, the sketch titled Chernobyl-Type Reactor seems to indicate that Soviet engineers have invented a new thermodynamic cycle, one running on hot water rather than steam. One might call the new device an internal evaporation engine.

Finally, the graph on page 49 is not clear. I would understand it better if Mr. Sweet had explained in the text how "neutron power" differs from power in general, which as an MIT freshman I was taught is the rate of doing work. Also, the label for the ordinate of the graph—%neutron power (in thousands)—appalls me. This locution was last heard on TV: a candidate was saying he supported his running mate "1,000 percent." Politicians don't know any better, which is why the president has a science advisor. But I expect more from a document edited at MIT.

SHEA LABONTE VALLEY
Concord, Mass.

The editors respond:
We welcome Ms. Valley's congratulations and apologize for the difficulty she encountered with the illustrations. Yes, the drawing depicts a fuel rod, and yes, the sketch of a Chernobyl-type reactor is incorrect. In regard to the graph, this is an artist's rendition of one of a number of calculations the Soviets have supplied in the wake of Chernobyl. We chose the neutron-power graph since it clearly illustrates the possibility that two explosions occurred. The Soviets labeled the ordinate "percent neutron power," and we didn't want to alter that.

THE PERILS OF PRESTIGE

In "Why Scientific Education Is Liberal" (*TR February/March 1990*) Jonathan Schlefer presents some interesting ideas about the conservatism behind his

own humanistic education. However, I don't think everyone who receives a humanistic education has the same experience. It's worth noting that every single literary figure referred to in the article is white and male—*of course* they are all nervously trying to preserve the status quo. Too bad Mr. Schlefer's college curriculum didn't include the likes of the British novelist and essayist Virginia Woolf or the Black American novelist and essayist Ralph Ellison. That might have given him more of a sense that not every author in Western literature makes a fetish of antiquity.

Perhaps the problem is not so much humanistic education per se as humanistic education at prestigious schools. I happen to know that Mr. Schlefer went to Harvard, where the faculty fully expects students to go on to hold Cabinet posts or edit influential national magazines. I, on the other hand, attended a large state university, and the general idea was that I would spend my life telling stoned high school kids about how to make verbs agree with their subjects. No one seriously believed the country's future depended on the "greatness" of the ideas I absorbed—which meant that I had more freedom, as did the people who were teaching me. Today my cultural background is more haphazard than Mr. Schlefer's, but at least I can say I wasn't heavily indoctrinated.

For one thing, I didn't have to wait until I was 40 years old to understand that T.S. Eliot is a reactionary. I knew about that when I was 19, and I didn't even have to figure it out for myself. The harried, opinionated graduate student who led my discussion section in modern American poetry clued me in. "OK, Eliot," he said one day at the beginning of class. "Eliot. Those of you who have read the assignment carefully may have noticed that Eliot is a jerk." And he went on to explain what he meant. "But don't worry," he added before getting down to what he always called major lit crit, "none of that is going to be on the test."

GINNY SCHRANK
Cambridge, Mass.

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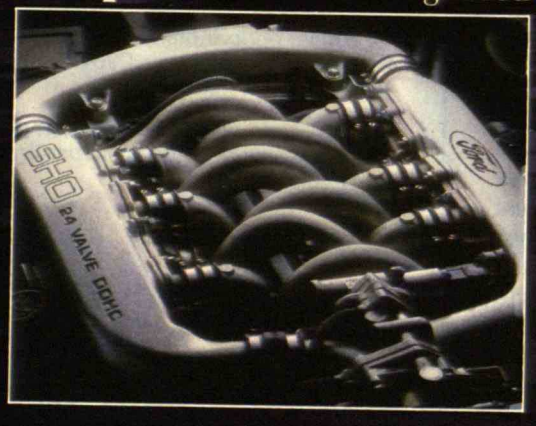
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If you are an engineer or scientist, we'd like you to consider Boeing as a place to pursue your career. That's what this advertisement is all about. It's based on the belief that a good way to learn about a company is to meet the people who work there. To that end, we'd like to introduce Dr. John McMasters, a research aerodynamicist and one of some 20,000 engineers at Boeing. In his workaday world, he helps design Boeing jetliners. In his spare time, he's a self-proclaimed paleoaerodynamicist.

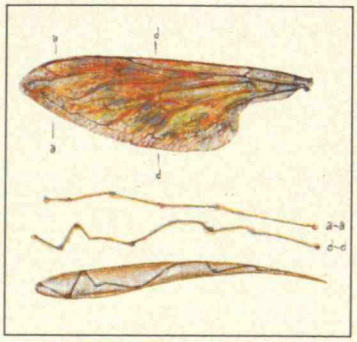




Ask Dr. John McMasters to define the proper field of study for an airplane designer and he'll say, "Everything that flies. All the time, professionally and avocationally."

That includes jetliners, certainly. And also insects, seeds, birds, bats, a certain reptile that executes aerial maneuvers of surprising grace and precision, hang gliders and boomerangs. Plus things that once flew, but don't now, such as pterosaurs.

Especially pterosaurs, in fact. They dominated flight for 120 million years and, reptiles or jets, all flying things encounter the same basic problems.



The irregular surface and tubular structure of insect wings are an elegant solution to a very difficult flight problem.

Sit back and ask McMasters to elaborate. It's a fascinating story.

You'll learn that 20 years ago, as a graduate student, he embarked on what he now describes as a ridiculously complex enterprise: the study of general locomotion.

"It was not the least bit modest," he says. "I envisioned a grand theory of optimal locomotion embracing the entire range of natural and man-made devices traveling through the air, on land, and in or on water."

His unified theory remains elusive, but the search has been hugely rewarding.

McMasters' investigations have included jumbo jets, bat wing architecture, the wing geometry of soaring birds, the

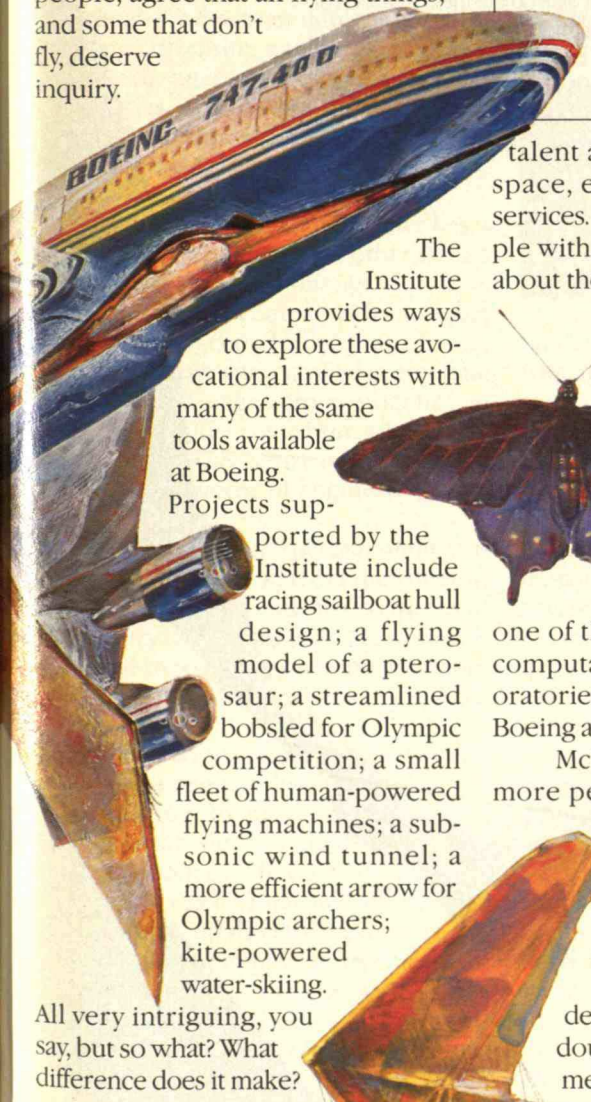
million years after reptiles learned to fly.

complexities of flapping flight, and similarities between hang gliders and flying reptiles.

Along the way, he helped found the Flight Research Institute (FRI). Members, including many Boeing people, agree that all flying things, and some that don't fly, deserve inquiry.



The pinion feathers at the wing tips of large land-soaring birds are a natural model for winglets on the newest Boeing 747 jetliner.



The Institute provides ways to explore these avocational interests with many of the same tools available at Boeing. Projects supported by the Institute include racing sailboat hull design; a flying model of a pterosaur; a streamlined bobsled for Olympic competition; a small fleet of human-powered flying machines; a subsonic wind tunnel; a more efficient arrow for Olympic archers; kite-powered water-skiing. All very intriguing, you say, but so what? What difference does it make?

There are at least two answers. McMasters points out that Boeing needs the best scientific and engineering talent available in aviation, aerospace, electronics and computer services. The company looks for people with ideas and a lively curiosity about the world and its possibilities.

Boeing supports inventive minds in many ways, contributing to higher education, helping employees pursue advanced degrees, creating courses and institutes if necessary, including one of the world's most advanced computational fluid dynamics laboratories—one of the tools used by Boeing aerodynamicists.

McMasters' second answer is more personal: "What began as a naive but serious enterprise has become a sort of merry drunkard's walk through a range of fascinating topics.

"My inquiries continue, despite suggestions from some doubters that there's little commercial value in designing better butterflies, and thus no merit at all in understanding how they work. I believe understanding the principles of flight helps make one a better designer of devices that do have commercial value.

"Equally important, I believe it's periodically valuable to stand back from the details of a career to see a whole picture—to see one's work in full perspective.

"The effort can be immensely refreshing. And humbling."



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If you have questions about the opportunities for scientific and engineering professionals, include a note specifying your area of interest, and a knowledgeable Boeing engineering representative will respond. We are an equal opportunity employer.

Dr. McMasters is a research aerodynamicist at Boeing Commercial Airplanes Division. He has taught at Purdue University and Arizona State University and has written 65 technical papers, reports and articles. He is preparing a book on the Biological Origins of the Aeroplane. McMasters is a graduate of the University of Colorado and Purdue.

BOEING

Asia Series

In Bangkok, good things come in enormous packages.

There was a time in Thailand when pachyderms meant political power, and a white elephant was worth its weight in gold. While times have changed—elephants today are used to symbolize good luck instead of wealth—there are still a number of big surprises in store for the businessman in old Siam.

Mai pen rai.

Pronounced "my pen rye," this is translated as "it doesn't matter," and it conveys the Thai attitude toward business and life as well. It means it's best to avoid open conflicts and negotiate patiently —shouting will get you nowhere.

Shy Thais.

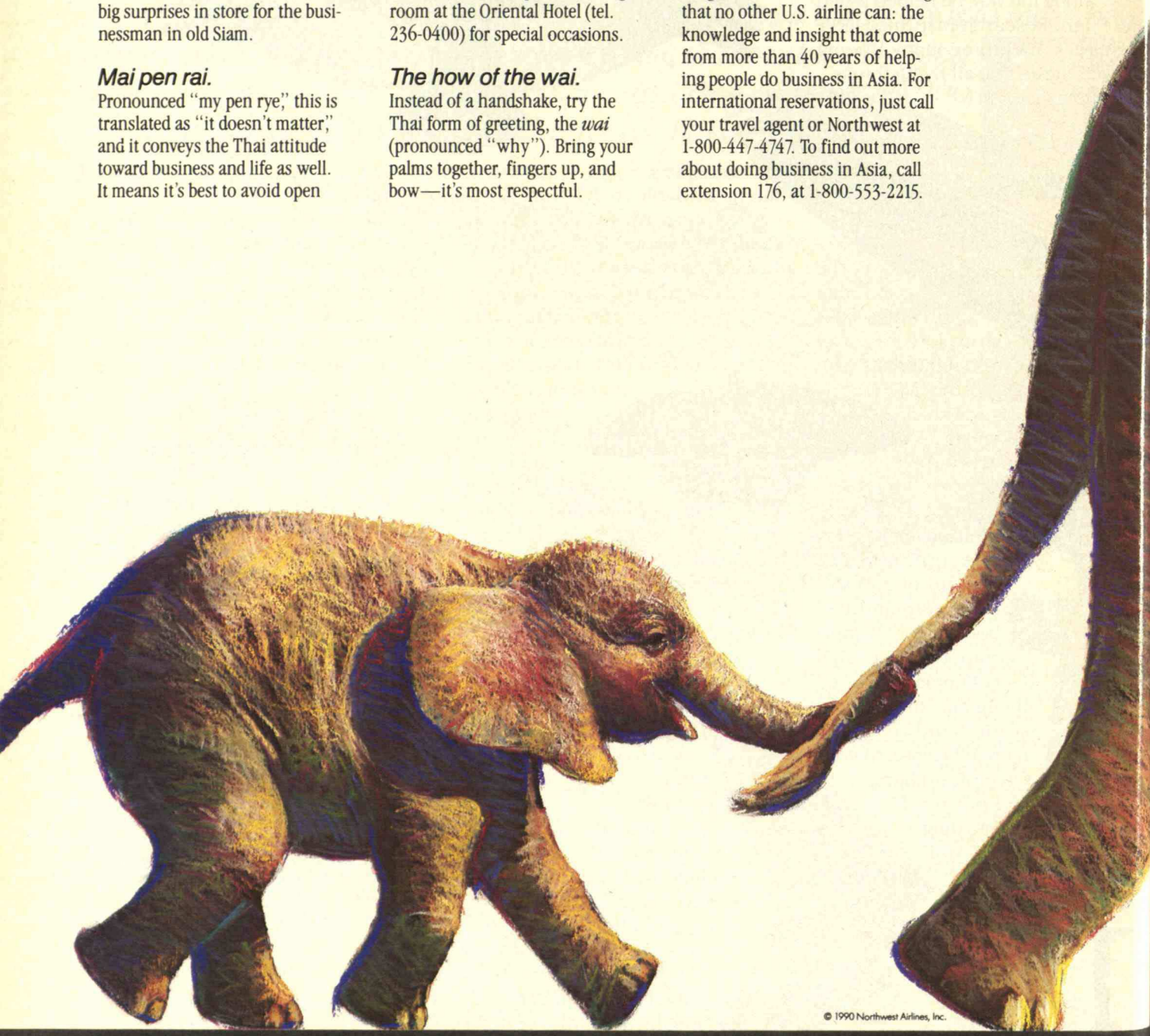
Thais seldom invite foreigners home—entertaining is done in restaurants. Use a private dining room at the Oriental Hotel (tel. 236-0400) for special occasions.

The how of the wai.

Instead of a handshake, try the Thai form of greeting, the *wai* (pronounced "why"). Bring your palms together, fingers up, and bow—it's most respectful.

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NORTHWEST AIRLINES

MIT Reporter

U.S. Engineering Shortages and Foreign Students

Angeline Ondaatjie, a Sri Lankan native in her senior year in MIT's materials science and engineering program, recently interviewed for a job with Texas Instruments. "I was cruising through the interview until the question of my citizenship came up," she says. When the interviewer learned of her student visa, which allows Ondaatjie to stay in the United States one year after graduation if she can find employment, "it was all over."

Even though the United States has a shortage of engineers and other skilled workers, labor and immigration laws discourage U.S. companies from hiring trained foreigners. Today, about 30 percent of all students enrolled in graduate science and engineering programs in U.S. universities come from other countries. Non-U.S. citizens account for about 60 percent of engineering doctorates.

At MIT, where 20 percent of the student body is foreign, fewer than one out of ten companies will talk to citizens of other nations about jobs. "It seems silly to be so restrictive on employment opportunities for these folks," says MIT President Paul Gray.

"How do we benefit from sending skilled foreigners home to work for competing firms?" asks Robert Weatherall, director of the Institute's career services. "If we let [graduates] stay here, these people will advance our industries and directly create jobs," he says. As an example, he cites mechanical engineering senior lecturer George Hatsopoulos, a Greek native who attended MIT and later founded Thermo Electron Corp. That company, which has more than 5,000 employees, manufactures co-generation systems and environmental and analytical instruments, among other things.

Cuneyt Ozveren's story is more typical. A native of Turkey, he has five MIT degrees, including a doctorate and three other degrees in electrical engineering, and a master's from the Sloan School of Management. In late 1989, after he had spent a year looking for a job in the United States, he still hadn't been able to land one. He decided that if he hadn't found a permanent position by March he would have to return to his country, even though he did not believe any industries there could make use of his very specialized technical knowledge.



At MIT, one of five students is from another country. The United States might benefit from the skills foreigners acquire at colleges and universities here.

From the perspective of U.S. companies, the procedure for keeping foreign workers can seem too complicated to be worth the trouble. Like Ondaatjie, foreign students usually come to the United States on a student visa. If they find employment after graduation, they can apply for a work visa that lets them stay up to five years. Before they can qualify for that, their employer must convince the Immigration and Naturalization Service that they have "distinguished merit and ability." And should a worker next apply for a permanent-resident visa, the company must show the Department of Labor that it has advertised the person's position and can't find a more qualified candidate. This certification process can take a couple of years—longer than many firms want to wait.

Moreover, companies often "think it's riskier to hire a non-resident, because he may go back to his home country," Ozveren says. But the argument doesn't hold water, since people in high-tech fields tend to move around often anyway. "An American can take a job and say goodbye after a year or less," he points out, but foreigners applying for permanent-resident status must stay with an employer at least two years.

For foreign students, the situation is a Catch-22. It's easy to get authorization to stay in the United States temporarily, as long as they have jobs. But getting jobs usually requires long-term authorization to stay and work.

Cutting Paperwork

To encourage an interest in foreign workers, Congress is considering a bill that would increase the number of skilled immigrants in the United States and cut down on employers' paperwork. If the legislation passes, the secretary of labor could state that companies in, for example, the southeastern United States—where there might be a shortage of electrical engineers—wouldn't have to justify their foreign hires on a case-by-case basis.

PHOTO: RANDALL WARNIERS

Sponsored by Edward Kennedy (D-Mass.) and Alan Simpson (R-Wyo.), the bill passed by a wide margin in the Senate last summer and is now working its way through the House of Representatives.

If labor and immigration laws do change, some observers say, that could further the "brain drain" from other countries, particularly those in the Third World. But "many students go home to find there's nowhere" to apply their specialized skills, explains MIT's foreign-student advisor Milena Levak. "The knowledge they acquired at MIT may be almost useless." Dorothy Zinberg, a professor in the Science, Technology, and Public Policy program at Harvard University's Kennedy School of Government, suggests that some countries might be better off letting their top scientists and engineers stay here until facilities are developed for them at home. The United States could serve as a kind of "brain bank."

As for cases where appropriate but lower-paid jobs exist in a student's homeland, "why should U.S. immigration laws make it easier for [another country] to hire engineers, if [that country] underpays them?" Weatherall asks. "My feeling is that we should make it easier for U.S. companies to keep good people."

Weatherall comments that the academic system is much more likely than industry to hire foreigners. "Universities don't have to do as much to prove" their need for someone because immigration authorities figure they have done a thorough search, he says.

Overall, 55 percent of the nation's assistant professors younger than 35 are not U.S. citizens, Zinberg notes. And these people comprise 83 percent of the junior faculty in electrical engineering. "Our universities would be in deep trouble if we didn't have these students and faculty," she says. "A number of engineering departments would not exist."—*STEVE NADIS contributes frequently to* Technology Review. ■

TechnologyReview

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REPEATING PRODUCT SUCCESS: HARDER THAN IT SOUNDS

Just four years after starting up, Kasper Instruments controlled some 50 percent of the market for photolithographic aligners, which expose patterns on semiconductor chips. But eight years later, the firm dropped out of the business altogether.

In part, Kasper design engineers did not recognize in time that a competitor had developed a much better lithographer, says Rebecca M. Henderson, assistant professor at MIT's Sloan School of Management. She thinks this was because of the communication setup at Kasper. The design team split up so that each person was responsible for examining and improving one part of the machine. If the engineers had collectively looked at all the parts instead, they might have realized that the superiority of the competitor's aligner lay in how its parts were put together.

Henderson uses that example to explain why manufacturers often can't repeat their success with a product. "This problem is more subtle than simple 'bureaucratic inertia' or 'overcommitment to old ideas,'" Henderson says. The issue applies even to companies that have "tried to set aside old prejudices and to make an unbiased assessment of [a] new technology."



To redesign products successfully, a company should examine its weaknesses, advises Rebecca M. Henderson, assistant professor at MIT's Sloan School of Management.

Because of assumptions about components or customers' needs, a company may not recognize that it has to significantly revamp a product. These assumptions are often buried deep within the firm's channels of communication and organization for product design, according to Henderson.

Henderson does not offer easy solutions but makes two general proposals. One is to increase the flexibility of organizations. Japanese companies often do this by moving their workers into a variety of jobs. A well-known way to increase flexibility in the United States is to set up a "skunk-works" operation—an independent team that tries to duplicate the conditions of a new company within an established one. But such groups aren't the perfect answer, Henderson cautions. In part, that's because skunk-works members, who usually have worked with the firm beforehand, may retain the attitudes they developed in the past.

Henderson also advises companies to attempt to spot major competitors' innovations as they occur. Toward that end, firms should ask themselves what they are particularly good at—and what

PHOTO: JUDITH V. STITT



The military could give civilians a basic education and a "sense of empowerment," says MIT dean Margaret Mac Vicar.

they aren't. This soul-searching may lead employees to try to understand why competitors act in unexpected ways, and then to organize themselves differently. Firms should also closely examine the information that competitors are paying attention to, even if it seems highly unusual. ■

TO TEACH CHILDREN, EDUCATE MOTHERS

Largely lost in the hue and cry over children's learning is the need to educate adults. The United States must develop a systematic way to reach "educationally disabled" people between 18 and 35, says Margaret Mac Vicar, MIT dean for undergraduate education and professor of physical science.

Mac Vicar, who sits on the Commission on the Skills of the American Workforce and other national groups concerned with education, says providing adults with a basic education is not only just but practical. Increasingly, people need such training to be in the workforce. And for the next 20 years, the majority of workers will come from the population that is adult now.

Mac Vicar is particularly concerned about single mothers who lack high school diplomas. Not only are such women unable to get decent jobs, but they set a poor example for their offspring. Parents have far more influence on children's interest in learning than teachers do. It's not enough for uneducated parents to "ask their kids to have an act of faith" and continue through high school, Mac Vicar says.

Mac Vicar would like to see the federal government develop an organizational plan and general curriculum for adult high school education. The curriculum would include reading, writing, and arithmetic, other skills helpful in the workplace, and some "survival" information on basic monetary matters like interest payments.

Among the organizations Mac Vicar thinks could help teach adults are the armed services. "The civilian sector hasn't paid adequate attention" to the military's "astounding track record" in providing young people with high school education and a sense of empowerment, she says. She adds that this success derives from developing camaraderie and discipline among students, and from breaking down skilled work into small tasks. These tasks permit sequential achievements that build confidence.

Given changing defense needs, Mac Vicar believes the best use for many of the military's physical plants and personnel could lie in educating adults. Such reform could boost the country's economic competitiveness.

Private companies could also help. Mac Vicar says that rather than simply underwriting programs, firms might actually teach courses themselves. The corporate sector might be good at that because it has so much at stake in improving productivity, she thinks. And companies could form partnerships with community colleges to play a significant role in basic adult education (*see "Training the Workforce of the Future," TR August/September 1989*).

Adult education won't be effective unless people receive a living wage while they are enrolled, Mac Vicar notes. She acknowledges that this could cost as much as $1 trillion, and that workers would have to be able to take time off from their jobs without losing them. Moreover, high school students who are on the brink of dropping out might do so, thinking that they could return and get money for taking classes several years later. Nevertheless, paying adults to learn would bring people back into the workforce, which is a good alternative to providing housing, food, and other social supports—sometimes even prison—forever, she says. "I think it would be a very good investment for the country. You either spend the money for policing and remedial assistance later or you spend it for education now."—*LAURA VAN DAM edits MIT Reporter.* ■

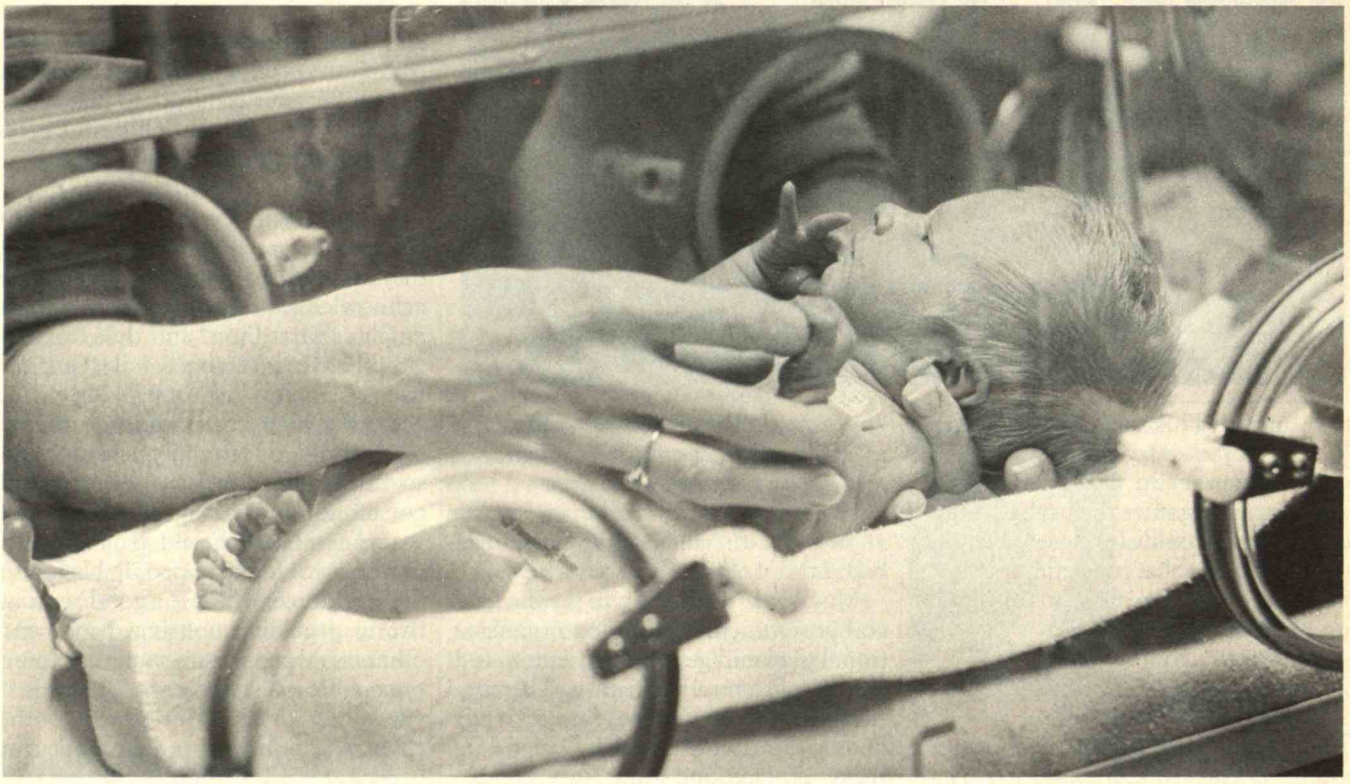
HOLEY HOUSING

The customary method of framing houses with two-by-fours is starting to give way. Now some builders are using large panels that contain hard foams sandwiched between wood or sheet metal. The panels make framing go faster and provide better structural support and insulation.

If loads are too heavy, however, the foams can deform and the panels can delaminate, buckle, fracture, and shear. MIT civil engineering professor Lorna Gibson is trying to determine just how this happens. Working with cement foam and exterior sheets made of wood fibers in a cement matrix, she is also attempting to develop a stiffer, noncombustible housing panel that wouldn't deform as much as today's sandwich panels. The cement foam is made by mixing wet cement with a foam produced by a foaming agent and air. ■

PHOTO: U.S. NAVY

Trends



Doctors can save babies that are born 17 weeks early. However, the price tag is staggering, and many of the infants have mental or physical handicaps.

Saving Young Lives

Since Bert Bunnell's high-frequency ventilator received federal approval last summer, 85 U.S. hospitals have purchased these computerized machines for saving premature infants. Called the Life Pulse, the ventilator helps infants take up to seven breaths a second. Increasing the rate of breathing while decreasing the size of each breath reduces the stress on immature lungs.

However, such technology can be a burden as well as a blessing. Today's neonatal intensive care units (NICUs) can save babies that are 17 weeks early and weigh about a pound, but many of the infants are either mentally and physically handicapped or die soon after leaving the hospital. And the price tag is staggering. The National Perinatal Information Center in Providence, R.I., estimates that the average hospital charge for infants weighing between 750 and 1,000 grams—about two pounds—was over $33,000 in 1985.

Still, the NICU is, indeed, a technological success story. The equipment in the 400 NICUs across the country saves more and more of the approximately 100,000 premature and sick babies hospitalized each year—about 10 percent of all babies. Fifteen years ago, doctors placed the survival threshold at about 1,500 grams—roughly 3 pounds. Now, they save 20 percent of 500-gram babies born at 23 weeks—infants that fit into an adult's palm.

Technology replaces a mother's womb in part with miniaturized versions of standard intensive-care equipment—wires, intravenous lines and breathing and feeding tubes, umbilical catheters, respirators, blood gas analyzers, and tiny probes to measure skin temperature. Neonatologists are also designing special preemie drugs, such as an artificial surfactant that keeps lung air sacs from sticking together as a baby tries to breathe.

Yet these advances lead to special medical problems. The very smallest babies can fall victim to chronic lung disease and blindness, as well as to brain hemorrhages that lead to severe damage. Infections are also a major threat—the undeveloped skin of very premature babies provides no barrier to infections or water loss. Moreover, such children have brittle bones, and they can't regulate their body temperature. The U.S. Office of Technology Assessment says that those problems, plus cerebral palsy, seizure disorders, blindness, deafness, and mental retardation, afflict up to 30 percent of infants under 1,500 grams.

A joint study by the Centers for Disease Control, the Georgia Department of Resources, and Emory Medical School found that NICU babies are five times as likely to die after leaving

PHOTO: BRADFORD F. HERZOG, COURTESY OF THE CHILDREN'S HOSPITAL

the hospital as are other infants. Congenital heart disease is the most common cause, followed by sudden infant death syndrome and infection.

Similarly, in 1985 the National Perinatal Information Center found that three-fourths of premature babies weighing between 500 and 749 grams died, as did about 30 percent of babies weighing between 750 and 1,000 grams. Overall that year, $1.9 billion was spent on premature babies born in the most advanced hospitals. More than 60 percent of the money went to care for 11 percent of the babies—those weighing less than five pounds.

Targeting Care

One way to lower the price tag is to prevent prematurity. In Los Angeles, an ongoing Cedar-Sinai Medical Center project to pinpoint the causes of low premature birth weight has estimated that counseling, bed rest, injecting hormones, and lessening stress reduce prematurity 32 percent.

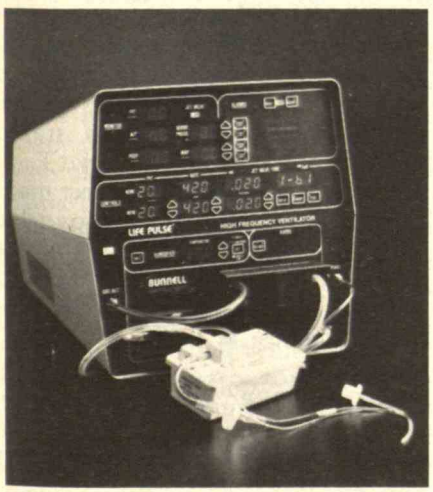
The role of stress—including financial worry—in leading to prematurity is a particularly important area of research, according to Laura Gardner of the University of California, Berkeley, School of Public Health. She has reviewed 20 years of research relating low birth weight to prenatal care, and recommends that all prenatal programs include psychological counseling as well as medical help.

For the first time, the federal Public Health Service has officially recognized the value of combining pregnancy counseling with regular visits to the obstetrician. In October 1989, the service recommended increasing the prenatal care available to women whose fetuses are at risk. Healthy women don't need many expensive and time-consuming procedures, such as blood-pressure measurements at every prenatal visit. But emphasis should be placed on helping women who, because they are poor, lack medical care, or abuse drugs, are more likely to bear premature and low-weight infants.

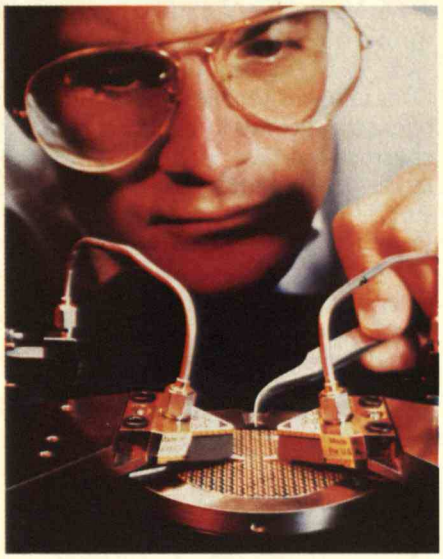
That advice is especially important because the expenses of prematurity are often beyond the ability of parents to pay. In a 1987 study of 61 hospitals, the National Perinatal Information Center found that more than a third of preemies were born to parents who couldn't pay the bill or paid it through Medicare. Vanderbilt University pediatrician Mildred Stahlman notes that the burden of premature births falls most heavily on those who can afford it least, "frequently still children themselves, unable or unwilling to undertake the requirements of parenting a high-risk infant."

Stahlman says that in her area of Tennessee, one-fourth of premature infants are born to teenagers, "many of whom do not want these babies." She says that the mothers often had no sex education and couldn't afford abortions. "This is a social problem," she says. "We have to provide some way that unwanted pregnancies don't happen." ■

Technology is replicating a mother's womb for premature infants. This high-frequency ventilator helps reduce stress on immature lungs.



RENEE TWOMBLY, a Knight Science Journalism fellow at MIT in 1988-89, is a freelance writer in Washington, D.C.



Pentagon researcher Steven Brown prepares to test a wafer containing hundreds of high-speed gallium-arsenide circuits for use in "smart" weapons.

Integrating the Pentagon's Circuits

With U.S. policymakers calling high technology the key to military and economic competitiveness, the Pentagon has ventured into technology planning. Nowhere is this more prevalent than in semiconductor technology, which a 1987 Defense Science Board task force called critical to the nation's defense and economy.

Fundamental to the Pentagon's semiconductor ventures is its experience, beginning in the late 1970s, in the Very High Speed Integrated Circuit (VHSIC) program. This just-concluded effort, consisting of three research teams sponsored by the Department of Defense (DOD), yielded chips one-sixth the size of those previously available. It was also notable for fostering information sharing and technology transfer among participating firms and to the private sector, and establishing standards for hardware and software design and testing.

PHOTOS: BUNNELL, INC.; MARTIN MARIETTA

However, the VHSIC program had numerous acknowledged flaws as well. It has led to very few applications in operational equipment. Moreover, the Pentagon awarded VHSIC contracts almost exclusively to the largest companies, virtually ignoring smaller but often more innovative firms.

Nor did VHSIC projects consider emerging technologies, such as gallium-arsenide chips. These now process data six to eight times faster than those based on silicon. They also resist electromagnetic interference from nuclear blasts, require much less power and space, and provide better sensor resolution. For DOD, high-speed data processing is critical for aircraft, missiles, sensors, and communications, while space and weight constraints of high-tech military systems demand miniaturization.

In fact, says Senate Armed Services Committee staffer Edward McGaffigan, the program's direct impact appears questionable, since "as much VHSIC technology is available from non-participating firms as from participants." Another bad sign is that there are more commercial than military VHSIC applications. Although that is fine for consumers, it does not reflect well on a high-profile, military-sponsored research program.

Today, the VHSIC experience informs plans for—and views of—DOD semiconductor programs. In particular, it underlies MIMIC—the Microwave/Millimeter-Wave Monolithic Integrated Circuit program—which the Pentagon initiated in 1986. The primary goal of the $500 million MIMIC effort is to mass-produce affordable, reliable, high-performance components. The projects are geared toward real-time (immediate) data processing and sensor fusion, which enables high-speed computers to integrate information from a variety of radars and other sensors.

Live and Learn?

To progress beyond VHSIC technology, MIMIC research is centering on gallium-arsenide chip production. By 1994, the Pentagon hopes to reduce the cost of gallium-arsenide microcircuits from $20 per square millimeter to about $.80 through improved manufacturing technologies, yielding chips that are more reliable and uniform.

The Pentagon has undertaken this task because private industry, which has little need for super-high-speed processors and none for chips that resist nuclear explosion, has generally stuck to silicon. Gallium arsenide is unstable, resulting in chip defects, impurities, and fabrication and design problems. Also, whereas silicon is universally available, the United States must import gallium.

MIMIC addresses several other criticisms of VHSIC. For example, it aims to reduce the time between the emergence of a new technology and its use in weapons. Thus, MIMIC emphasizes integrating design, material processing, and manufacturing.

However, some VHSIC shortcomings are being repeated. Just as the old program overlooked gallium arsenide, MIMIC isn't experimenting with several newly developing technologies, such as indium compounds. Bell Laboratories researchers report that using indium, an element related to gallium, can triple data-processing speeds compared with gallium arsenide. Moreover, the biggest companies dominate MIMIC. Many smaller high-tech firms, uninspired by the limited applications for the program, prefer to concentrate on generic chips that have potentially wider use.

Without widespread commercial applications, MIMIC might not encourage the R&D that is crucial to international competitiveness in the semiconductor industry—a stated goal of the Pentagon. As Steve Temple, Raytheon's MIMIC project manager, notes, MIMIC discoveries "won't be pervasive unless you get volume applications" to cut costs and improve manufacturing and processing techniques. ■



The Defense Department's MIMIC program is developing sophisticated chips. One application might be in the displays for the advanced tactical fighter.

JAY GOLDBERG is an operations-research analyst at Martin-Marietta in Washington, D.C. He writes on military and high-technology issues.

PHOTO: DEPARTMENT OF DEFENSE

Greenhouse Initiatives

Like a massive weather front, greenhouse angst swept across the nation after congressional hearings two summers ago, when James Hansen, director of NASA's Goddard Institute for Space Studies, announced that "global warming has begun." The media sounded the alarm, expert opinions were heard, and special reports drafted.

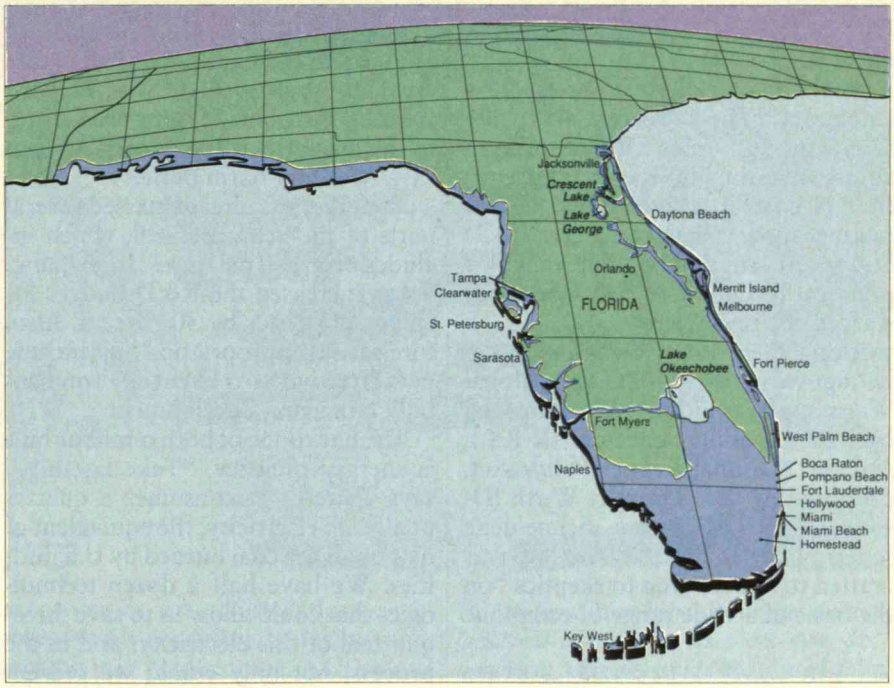
By November, the United Nations Environment Programme (UNEP) and the World Meteorological Organization, meeting in Geneva, had concluded that climate change was "the most important environmental concern of our day." UNEP director Mostafa Tolba called for a draft of an international agreement to be ready for this year's Second World Climate Conference.



James Hansen's 1986 testimony sounded the alarm on global warming.

Indeed, legislation to save us from a global hothouse has appeared at every level, from municipal ordinance to global convention, and the list of proposals that have been enacted, while short, is growing. Sweden's parliament has approved a policy to freeze carbon-dioxide emissions at 1988 levels and to tax emissions by 1991. The Netherlands, Norway, and West Germany are debating various proposals, and the United Kingdom is evaluating ways to improve energy efficiency and control methane, a potent greenhouse gas.

In the United States, Congress is debating several comprehensive climate and energy policy bills, while at the state level, notes Worldwatch Institute senior researcher Christopher Flavin, some 130 bills were introduced in 22 legislatures during the first half of 1989. Flavin, who authored a recent Worldwatch paper on slowing global warming, says Oregon's law mandates reducing greenhouse gases 20 percent by 2005. Vermont is moving forward on Gov. Madeline Kunin's proposals to curb emissions and support energy-efficient technologies, and by June California expects to complete a comprehensive state plan.



Global warming could raise sea level two feet by the end of the next century. Some say it could rise 12 feet, leaving most of southern Florida underwater.

Good intentions notwithstanding, there is hardly unanimity on what action, if any, to take. An underlying issue is money. The most pessimistic projections of what it might cost to curb the greenhouse effect look like military budgets. Harvard University political economist Thomas Schelling is skeptical that voters will foot the bill. "When it comes time to talk about raising the tax on gasoline to where the price is $2 a gallon, 99 percent of the population is going to balk at paying that price just because someone says Bangladesh may be flooded 75 years from now."

Moreover, some scientists charge that global warming is a legislative umbrella under which other agendas are being served. For example, MIT meteorologist Richard Lindzen concedes that the scare may force a sane long-term energy policy, but he doubts the scientific credibility of claims that catastrophic warming is inevitable.

Satisfying the Cynics

Nevertheless, the call to action has reached even the White House, which had tried to censor Hansen's congressional testimony. In January 1989, Secretary of State James Baker declared, "We can probably not afford to wait until all of the uncertainties have been resolved before we do act."

Hansen does not believe the United States needs to spend a trillion dollars. "I think that there are a large number of actions we should take, and they

PHOTO: NASA

fall into the category of measures that make sense anyway."

Flavin at Worldwatch is even more emphatic. "The measures are really fairly modest ones. We're talking about investing in energy efficiency that is cost-effective today. We're talking about rebalancing our R&D budgets to support a wide range of practical technologies that have been starved for resources."

Along these lines, Congress is debating two major bills, the Global Warming Prevention Act, proposed by Rep. Claudine Schneider (R-R.I.), and the National Energy Policy Act, proposed by Sen. Timothy Wirth (D-Colo.). Michael Totten, Schneider's senior policy analyst, says her bill was crafted to appeal even to skeptics "on the basis of a wide range of economic opportunities that are non-coercive and non-draconian. If 10 to 15 years down the pike we find that Richard Lindzen turns out to have been closer to the mark than Jim Hansen, we can say, 'Well, no harm done.' "

Congress has already passed several parts of the Schneider bill, which includes over 100 measures. In so doing, it has increased the R&D budget for energy efficiency by 30 percent. Also, foreign-aid appropriation bills include new directives to prevent environmentally damaging development.

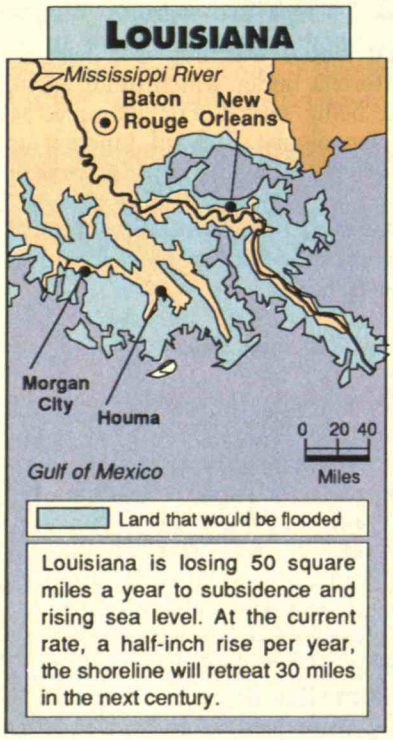
The backbone of both omnibus bills is energy efficiency. "Take lighting," says Totten. "It consumes a quarter of all U.S. electricity, the equivalent of half of all the coal burned by U.S. utilities. We have half a dozen technologies that could allow us to save three-quarters of this electricity, and in the process, not only would we prevent the combustion of over 100 million tons of coal per year, but we would also save U.S. consumers $25 billion on their utility bills."

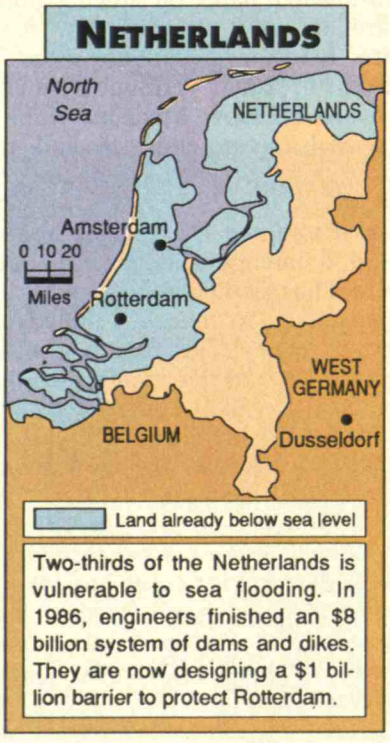
It would seem that measures that pay for themselves would have been adopted years ago. But the path to energy efficiency is complicated and requires powerful government incentives. Moreover, Flavin points out, "the energy committees are dominated by representatives from big energy-producing states who typically want what's in the interest of oil and gas, coal, and nuclear power."

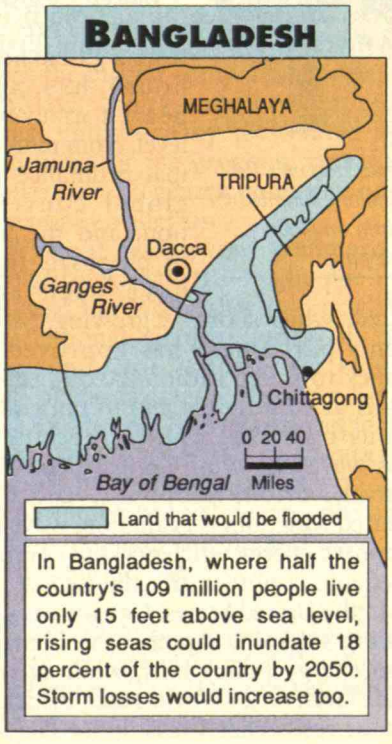
On the other hand, he says, this year's long list of important political and scientific meetings on global warming will increase the pressure to act. Undoubtedly, the fact that the entire House is up for election in 1990 will also play a role. Thus, while the science of climate change is likely to proceed incrementally, policy could leap forward if Congress decides that slowing global warming is the politically right thing to do. ■

DAVID BJERKLIE is a Knight Science Journalism Fellow at MIT and a science reporter for Time.

Rising seas threaten low-lying coastal plains, river deltas, and ports. Throughout the world, governments are considering ways to limit the damage, but the cost makes resistance high.







MAPS: CINDY JONES-HULFACHOR, ATLANTA JOURNAL-CONSTITUTION

The Tritium Factor

In June 1988, the Department of Energy (DOE) shut down the third of its three reactors at the Savannah River Plant (SRP) in Aiken, S.C. In so doing, the department declared the nation's only facility for manufacturing tritium, a vital component in nuclear weapons, too old and decrepit to operate safely. Since then, some disarmament advocates have proposed that keeping SRP shut would be an effective way to restrain arms production.

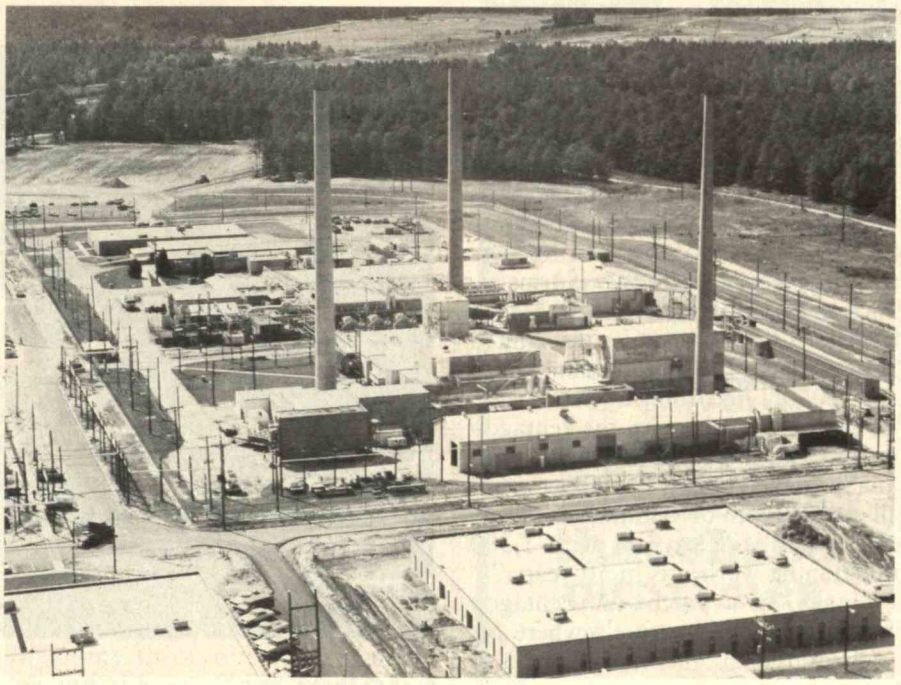
Like plutonium, tritium, which is a radioactive form of hydrogen, is required for all nuclear warheads. But unlike plutonium, weapons need only a tiny amount of the gas—typically about four grams, depending on how long it will remain in the warhead. While plutonium decays slowly, tritium breaks down at a rate of 5.5 percent annually. Hence, weapons must be replenished with it within six years.

That could be a problem for the Pentagon. The DOE has announced that the first Savannah River reactor probably won't reopen until fall 1990, and tritium takes at least six months to manufacture. So fresh tritium won't be available until mid-1991.

In October 1988, a Pentagon official declared that if Savannah River's reactors did not restart soon, the effect on America's ability to maintain its nuclear deterrent would be "tantamount to unilateral nuclear disarmament." The DOE also stressed that at least one reactor had to reopen by January 1989. The Energy Department began lobbying Congress strenuously and obtained $300 million in FY 1990 to start building two new tritium reactors. DOE's current estimates say these may cost $7.5 billion and take 10 years to complete.

But a number of public-interest groups differ with the Energy Department over reopening SRP. For example, the Nuclear Control Institute (NCI), a research organization that concentrates on proliferation, proposes simply repairing the facility and keeping it in cold storage. NCI wants to halt tritium production for military use and place commercial supplies under international safeguards. (Tritium has a small market for medical research and for illuminating signs.)

According to NCI, one way to do that would be to revise the two-decade-old Non-Proliferation Treaty, which will be reviewed as early as this June in preparation for renewal in 1995. Last May, the Soviet Union offered to stop producing enriched uranium and plutonium, so it might be willing to halt tritium production. However, the Bush administration has turned down the Soviet suggestions so far, so tritium controls seem unlikely.



The Savannah River Plant's tritium production facility has been shut for two years. Many disarmament advocates would like to keep it that way.

Much Ado about Nothing?

In any case, DOE has substantially changed its own story over the past year. By late 1989, it seemed to be saying that no tritium shortage exists. In fact, the country may actually have a surplus. And if Savannah River reopens this fall, there will have been no damage to national security even after an unprecedented three years of no new tritium production.

DOE has said that despite several accidental losses of its apparently dwindling tritium—once during an experiment to find a way to transport the gas without losing it—the agency plans to resume selling it commercially.

At the same time, DOE has lowered its projected cleanup costs. A few months after SRP's closing, DOE had estimated the cost of cleaning and refurbishing SRP and its other weapons plants at $100 billion to $150 billion—high even by the standards of weapons programs. Now, although DOE continues to press for new reactors, it has lowered the cleanup estimate to $24 billion—and Energy Secretary James Watkins says the price could be much lower.

As a result, most arms-control advocates have continued to propose freezing weapons systems, not tritium. And SRP critics say there is less reason than ever to reopen the plant. David Albright, senior staff scientist at the Federation of American Scientists, thinks the Pentagon not only appears to have all the tritium it needs, but it could use its supplies more efficiently.

PHOTO: DEPARTMENT OF ENERGY

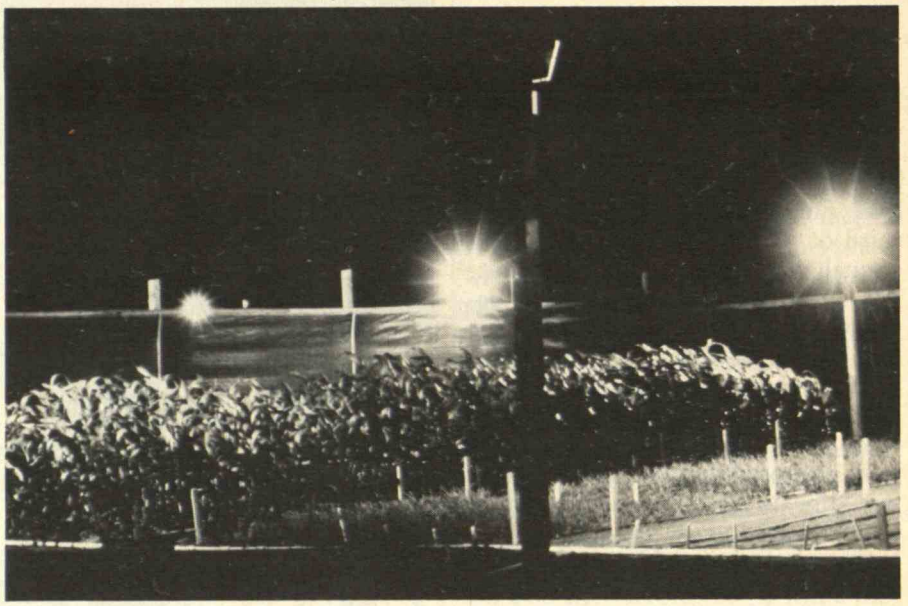
Albright adds that reductions in nuclear arsenals imposed by the recent INF Treaty—plus the prospect of further cuts in the wake of a START treaty—also reduce the need for new tritium. He speculates that if arms reduction continues past START to a level of 1,000 warheads, the United States will not need new tritium "until after 2030." According to Greenpeace lobbyist Steve Schwartz, the Pentagon retires roughly 500 warheads annually anyway: "Even if DOE stopped all production of tritium, its decay rate would still leave us with 1,300 functioning warheads in 50 years."

Finally, in a pinch, the Pentagon presumably could turn elsewhere for tritium. DOE may have already brought some in secretly from Norway or Great Britain. Greenpeace, acting on a tip from British nuclear workers, thinks it spotted a tritium shipment arriving at Portsmouth, Va., last spring. DOE maintains that the containers in question held uranium hexafluoride for manufacturing enriched uranium.

Ironically, the prospect that the Pentagon actually has plenty of tritium may be a setback for Canada, whose commercial reactors produce it in the course of normal operation. Ontario Hydro's tritium extraction plant, despite a recent shutdown and numerous safety problems, could supply most of the global civilian demand, and Canada has already allowed sales to at least two DOE customers.

Still, Canada prohibits the export of tritium for military purposes, and some Canadians are concerned that commercial sales will swell DOE's stockpile of tritium for weapons. "Canadians don't want to think of themselves as bomb builders," explains Norman Rubin, director of nuclear research for Energy Probe, an anti-nuclear watchdog group in Toronto. ■

ANN MARIE CUNNINGHAM is a regular contributor to Trends, specializing in defense technology.



Artificial light in experimental farming on Mt. Haleakala, Hawaii, adds two, four, or six hours to the growing day for corn and rice.

Global Experimental Farm

If a crop grows on Hawaii, it'll grow anywhere. . . . With the islands' idyllic weather, who would believe such a proposition? Nonetheless, it underlies the efforts of agricultural researchers to turn parts of Maui into an information bank for beleaguered Third World farmers.

Given the rainfall, temperature, and soil of any area, chances are that some part of Hawaii has conditions that mimic it, claim researchers at the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT). If a crop flourishes at "MauiNet," they add, it will—with 75 to 80 percent certainty—prosper where you are.

Funded primarily by the U.S. Agency for International Development (AID), teams of researchers have established 22 mini-farms around the base and up the 1,000-foot flank of Mount Haleakala. The climate at each growing site depends on how high up the mountain it is. Within a 90-minute drive, temperatures range from tropical to frost-forming, while yearly rainfall varies from a New Mexico-like 10 inches to a very wet 300-plus inches, from tropical wetlands to mountain pastures that call to mind springtime in the Rockies. "We can simulate almost every summer condition in the world," says Michigan State University agronomist Joe Ritchie, a member of IBSNAT's science advisory team.

As a result, researchers can work with diverse crops in what University of Hawaii agronomist Gordon Tsuji calls "the world's experimental farm." Below 1,000 feet, tropical crops such as pineapple, sugarcane, and bananas grow. Vegetables thrive above 1,000 feet. Above 2,000 feet, potatoes, wheat, corn, and other grains flourish, while peaches, apples, and pasture grasses prosper above 3,000 feet.

Still, even Hawaii can't mimic all growing habitats. Although the islands are tropical, they have no true monsoon. Researchers can't imitate the effects of foreign pests or diseases, nor does Maui suffer the one season that is the bane of many North American farmers: winter.

Nevertheless, to imitate agriculture elsewhere, electric lights artificially change the length of days at some test sites. This allows agronomists to re-

PHOTOS: IBSNAT PROJECT, UNIV. OF HAWAII AT MANOA

create spring and fall sunlight for many areas that are much farther from the equator than Maui. Thus, crop scientist Anthony Hunt of the University of Guelph in Ontario can plant Canadian wheat on Maui. He hopes to tease out the answer to the question of how various strains use heat and light as cues to begin sprouting.

Third-World Alternatives

But it is the interests and needs of the Third World that IBSNAT addresses most directly. Within a small area, MauiNet's mini-farms mirror 90 percent of the tropical growing conditions that characterize the majority of Third World nations.

One AID project taking advantage of Maui's ideal climate is "NifTAL"—nitrogen fixation by tropical agricultural legume. To help Third World farmers, researchers are finding which crops and strains of crops can thrive in certain regions without expensive and polluting nitrogen-rich fertilizers. For example, NifTAL director Paul Woomer and B. Ben Bohlool, a graduate student at the University of Hawaii, have studied how well different strains of rhizobia fare at several MauiNet sites. This common bacteria forms a symbiotic relationship with many members of the bean family, allowing them to take advantage of the nitrogen in air.

Using data collected from around the world, IBSNAT is also trying to create computer models for 12 of the world's major food crops, including millet, corn, rice, sorghum, wheat, soybeans, taro, barley, and potatoes. Researchers have already designed software that models how different strains of soybeans, peanuts, wheat, and corn will perform in various tropical locations.

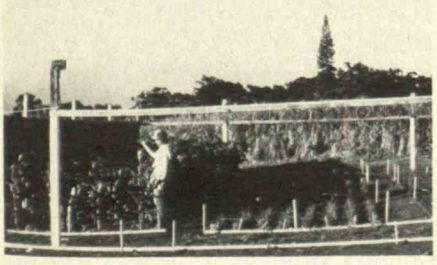
Once such a model is created, Hawaii becomes the site to test its accuracy. But does "real life" on Maui validate the computer simulations? According to Tsuji, experiments there show the model's predictions are 75 to 80 percent accurate for those four crops.

"I think right now the days of doing the same thing over and over all around the world are over," says Tsuji. Crops might be tailored to each location. Moreover, farmers in each country wouldn't have to duplicate experiments elsewhere. "When we know how a crop will respond [here], we should be able to take the same crop, plant it elsewhere in the world, and it will perform," he explains.

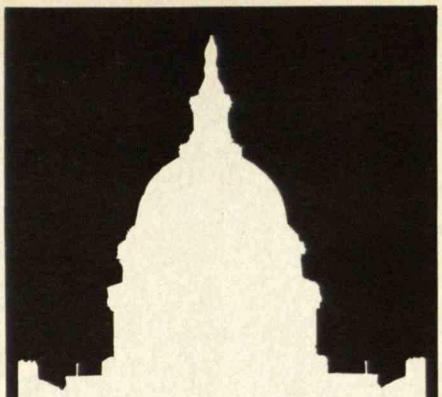
Furthermore, as agronomists grow more confident of their data, the agricultural computer models are becoming more sophisticated. By taking such variables as economic factors into account, IBSNAT could advise Third World policymakers and farmers who are being pressured by outside forces to change millennia-old cultivation habits.

One such force might be the global warming associated with the greenhouse effect. Another is the U.S. effort to curtail the cultivation of plants that yield illegal drugs. As Tsuji asks rhetorically, "Can you find some alternative to poppy-growing in Southeast Asia?" If MauiNet produces such an alternative, many Third World farmers might be freed from their economic dependence on the drug trade. ■

Small plots separated by fences test different ways to grow the world's major food crops better.



STEPHEN STRAUSS is a science writer at the Toronto Globe and Mail *and a regular contributor to Trends.*



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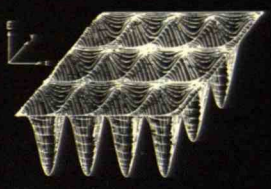
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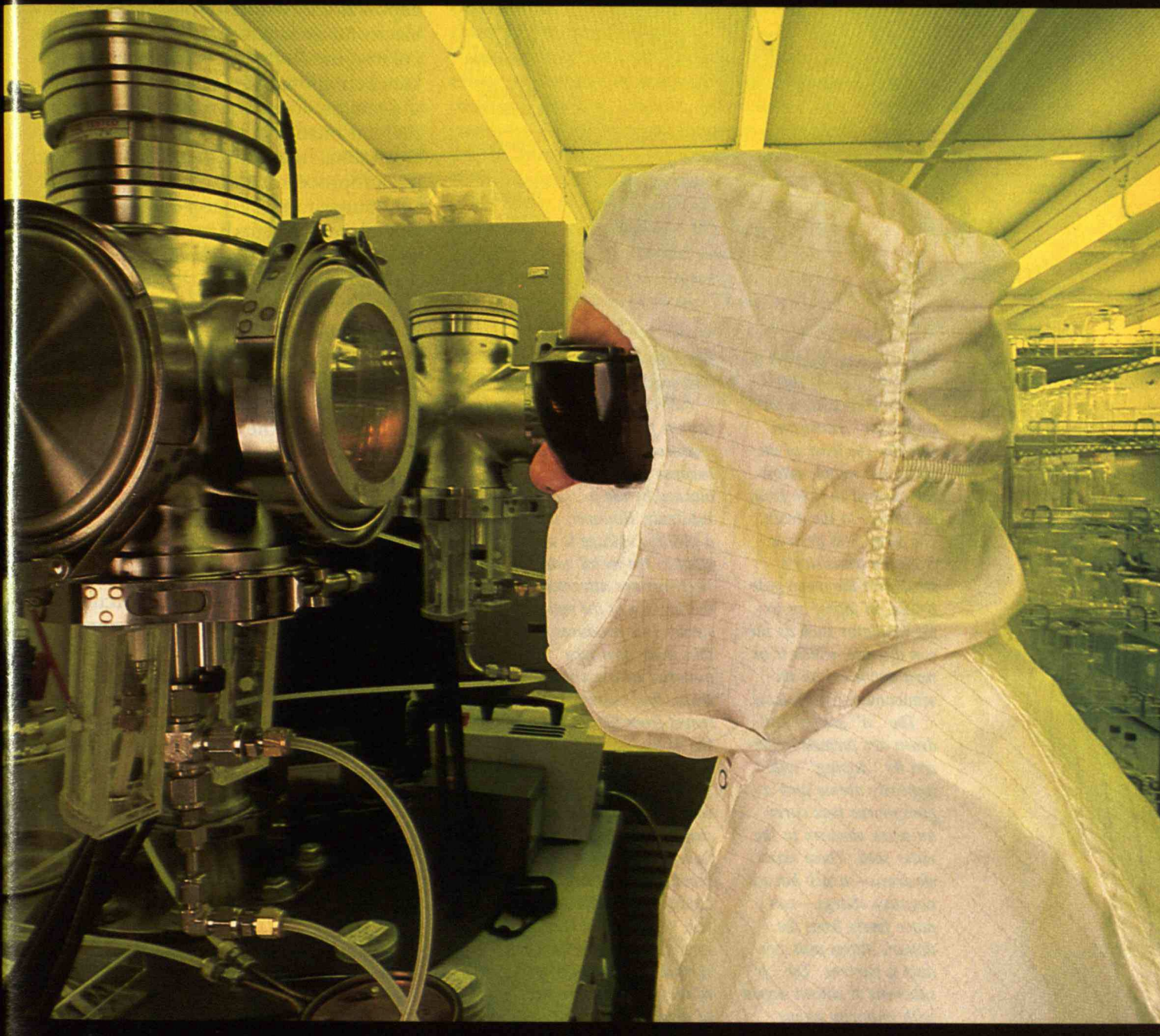
SEEKING A RADICALLY NEW ELECTRONICS

As conventional circuits approach their limits in the next decade or two, researchers hope to continue the electronics revolution by exploiting "quantum effects" in structures approaching the size of large molecules.



THE modern electronics revolution began 43 years ago with the invention of the transistor. Soon transistors began to replace electron tubes in radios and other electronic equipment, including computers. Surprisingly, it took 13 additional years before the idea of combining more than one transistor on the same piece of semiconductor material was demonstrated independently by Robert Noyce of Fairchild Corp. and Jack Kilby of Texas Instruments, inaugurating the era of the integrated circuit. Once this

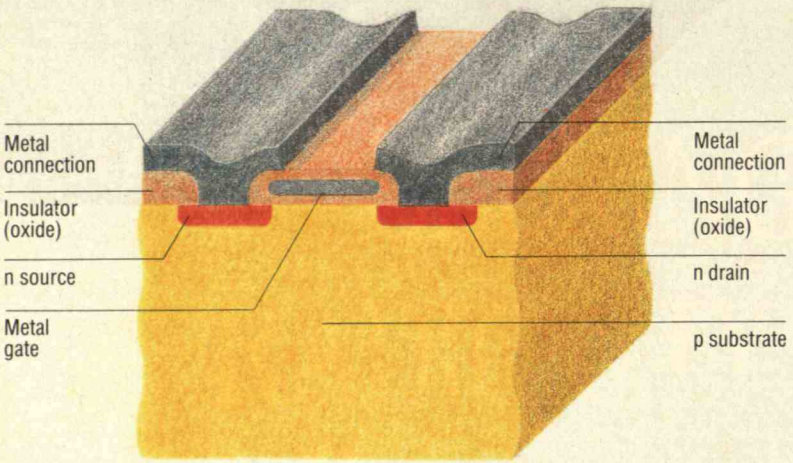
By Henry I. Smith and Dimitri A. Antoniadis



Researchers at MIT's Submicron Structures Laboratory fabricate devices with features only a little more than 100 atoms across. These are used to study quantum effects—the wave-like behavior of electrons confined to small areas.

PHOTOGRAPH: BARRY HETHERINGTON

1



***1** A voltage applied to the metal gate of this MOS (metal-oxide semiconductor) transistor acts like the lever of an electronic switch, allowing current to flow from the source to the drain. The term MOS derives from the transistor's structure: the* metal *gate is laid on top of an* oxide *insulator such as silicon dioxide, which is in turn deposited on the* semiconductor *substrate.*

The "n" source and drain are formed in silicon by "doping" with impurity atoms such as phosphorus that carry an extra electron in the outer shell. These extra electrons—which have a negative charge*—can move freely from the dopant atoms and conduct a current. The "p" substrate is silicon doped with impurity atoms such as boron that are short an electron in the outer shell. These missing electrons, called "holes," can also move freely from the dopant atoms and conduct a current.*

Current ordinarily cannot flow between the n-source and the n-drain because electrons are blocked by the p-substrate. However, when a positive voltage is applied to the metal gate, electrons are attracted to the surface of the substrate. This produces a thin layer of n-type material with extra electrons, and current can travel from the source to the drain.

Improvements in integrated circuits, which combine numerous transistors on a chip, have fueled the electronics revolution and will proceed for a decade or two. Commercial transistors can probably be shrunk economically until they have feature sizes of around 0.1 to 0.2 micrometers (millionths of a meter). Continuing the electronics revolution will require a radically new approach.

conceptual leap had been made, the complexity of integrated circuits and their ability to perform useful functions grew exponentially with each passing year. New electronic products such as the pocket calculator, the electronic watch, and the personal computer were created and became ubiquitous. Today, the most advanced commercial memory chips contain 4 million transistors. Intel Corp. recently announced a microprocessor chip that contains 1 million transistors. Desktop computers built of such components have more computing power than room-size supercomputers had a decade ago.

The integrated circuit created a multi-billion-dollar industry, revolutionizing consumer electronics, military systems, communications, computers, and our entire way of life. This electronics revolution has been fueled by the unrelenting miniaturization of transistors, which has permitted commensurate increases in the complexity and sophistication of integrated circuits. However, continuing the electronics revolution well into the next century will require a radical departure from the conventional types of electronic devices and circuits that we have used until now. One reason is that transistors do not work well if they are miniaturized beyond a certain size. Another is that every transistor must have wiring to each of its terminals. As more and more transistors are packed into a small area, we get a nightmare of multi-level, crisscrossed wiring. More and more of the circuit area is taken up by this wiring in much the same way that population growth in a city leads to a roadway maze and traffic congestion—the "Los Angeles problem." Fi-

HENRY I. SMITH, professor of electrical engineering and director of the Submicron Structures Laboratory at MIT, has pioneered techniques for fabricating nanostructures (with features measured in billionths of a meter). His recent work has focused on quantum-effect electronics. DIMITRI A. ANTONIADIS, professor of electrical engineering and director of the Microsystems Technology Laboratories at MIT, is known for his work on modeling and simulation of silicon technology and his research on electronic devices with extremely small features. *Major results discussed in this article constitute the recent thesis work of Khalid Ismail and Ghavam Shahidi. The work is sponsored by the Air Force Office of Scientific Research, the Joint Services Electronics Program, and the National Science Foundation.*

DIAGRAMS: TOM BRIGGS DESIGN

nally, both the wiring and the transistors give off heat, and the problem of dissipating it eventually becomes a limiting factor.

To bypass these roadblocks we need a radically new approach to electronics, one that will enable us to continue shrinking semiconductor devices and increasing their packing density without incurring a penalty. One possibility is "quantum-effect electronics." In this relatively new area of research, semiconductor structures are made small enough to exploit the quantum nature of electrons.

According to the theory of quantum mechanics, an electron will display particle-like behavior when it is free to move in regions substantially larger than its wavelength and wave-like properties if it is confined in regions comparable to its wavelength. Conventional transistor dimensions are large compared with electron wavelengths, so we can treat the electrons as classical particles. Transistor properties, by and large, do not invoke quantum mechanics. But in recent years, researchers have developed techniques to fabricate semiconductor structures with dimensions comparable to electron wavelengths. This has enabled scientists for the first time to see electrical characteristics that clearly manifest the wave-like properties of electrons. Exploiting such quantum effects may be the key to a new phase of the electronics revolution, since small size is a prerequisite rather than a problem. The smaller the structure or device, the more effectively it should function.

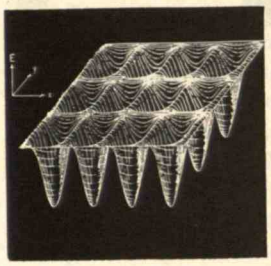
To grasp just how small we mean, consider the following comparisons. A human hair is about 75 micrometers (or millionths of a meter) in diameter. Transistors in the early integrated circuits (circa 1960) had minimum feature sizes that measured about 25 micrometers. The most advanced commercial transistors today have "channel lengths"—the key length scale of the most widely used type of transistor—that measure 0.75 micrometer, 100 times smaller than the diameter of a human hair. The quantum-effect electronic devices we are experimenting with in our lab at MIT have features measured not in micrometers but nanometers (or billionths of a meter). Some features of these devices are only 25 nanometers—3,000 times smaller than the diameter of a human hair, or a little more than 100 atoms across.

For the moment, our work on quantum-effect electronics is not aimed at building practical devices, circuits, or systems. Instead, we are focusing on methods for making quantum-effect structures, studying their properties, and comparing observations with theories that our group and others are developing. We believe the knowledge we gain could eventually enable us to build systems capable of computation and other functions. These will, of necessity, be based on radically new principles that bypass the wiring crisis of conventional systems. If we succeed, engineers of the next century will build computers many orders of magnitude more powerful than current ones, making feasible systems that interact in human language, evaluate complex visual images, make intelligent judgments, and solve massive numerical calculation and simulation problems.

The Limits of Conventional Circuits

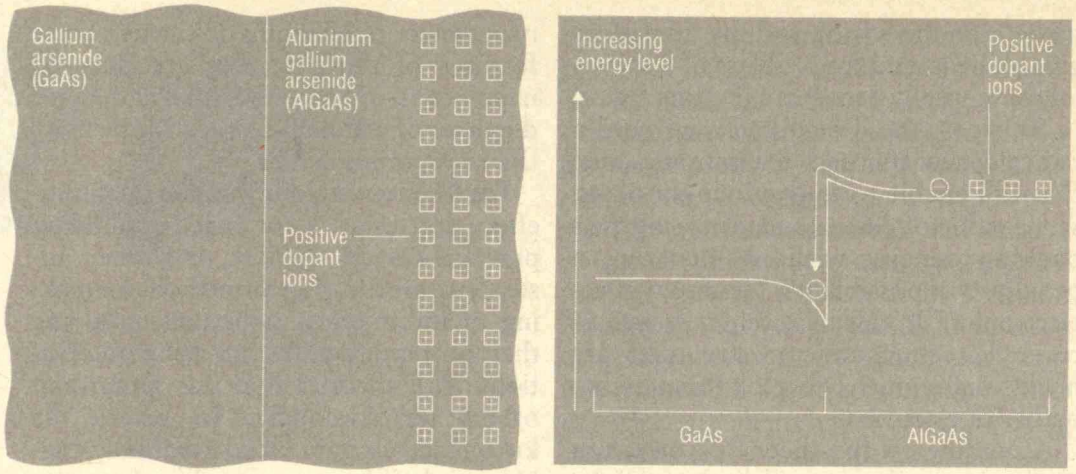
A transistor is a switch that turns a current on and off (or, in some applications, continuously modulates the current). A typical example is a conventional "metal-oxide semiconductor field-effect transistor" or MOSFET (*see figure 1*). The MOSFET consists of a "source," "gate," and "drain" built on a semiconductor material such as silicon. Electrons flow from source to drain through the channel underneath the gate only when sufficient positive voltage is applied to the gate. Thus, the gate acts like the lever of a switch, turning the transistor on and off. An integrated circuit, often called a chip, is a collection of many transistors on the same piece of semiconductor, interconnected to form a circuit that performs a useful function.

Since their invention in 1960, the exponential increase in functionality of integrated circuits has resulted from progress in five major areas. Researchers have shrunk the size of transistors and their interconnecting wiring, increased the size of



Some features of quantum-effect devices are 3,000 times smaller than the diameter of a human hair.

2



2 *"Modulation doping" captures electrons at the interface of a layer of aluminum gallium arsenide (AlGaAs) and a layer of gallium arsenide (GaAs). A cross-section of the two layers is shown at left. This technique is important for fabricating quantum-effect structures—structures with features so small that they exploit the wave-like nature of electrons.*

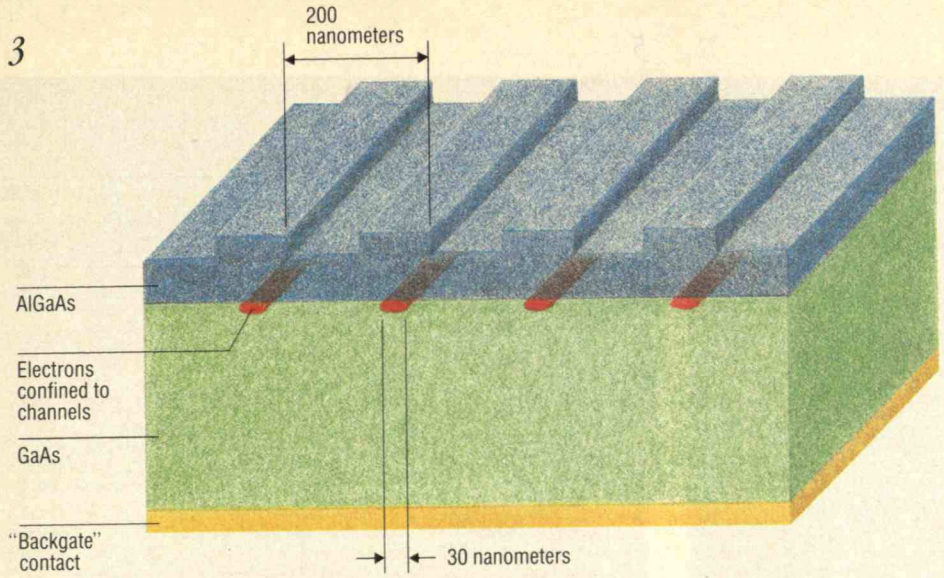
The AlGaAs and GaAs form a continuous single crystal, but their chemical compositions differ. That causes a drop in the energy of electrons at the interface between them—electrons will move from the AlGaAs to the GaAs, as shown at right. The AlGaAs away from the interface is doped with impurity atoms that have an extra electron in their outer shells. These electrons move into the GaAs, leaving positive ions behind in the AlGaAs.

The electrons remain in the GaAs but the positive ions attract them toward the AlGaAs. Thus, they are confined at the interface of the two materials in a "potential well." The electrons are free to move in the plane of the interface and form a "two-dimensional electron gas."

integrated-circuit chips, and refined circuit design so that fewer transistors are needed per task. Improvements in the manufacturing process—particularly, its cleanliness—have reduced defects and lowered costs, and multi-level wiring in integrated circuits has made it possible to send signals from one transistor to another at a remote location on the chip. These trends will no doubt continue. Evolutionary improvements in commercial integrated circuits should lead to transistors with feature sizes of around 0.25 micrometer, perhaps in the mid- to late-1990s.

It is technically possible to make even smaller transistors (we have made them as small as 0.06 micrometer), and in some respects, they work better than today's commercial transistors with channel lengths of 0.75 micrometer. As the channel length drops below 0.15 micrometer, the average velocity of the electrons traveling from source to drain increases beyond a so-called saturation velocity because the electrons undergo only a few collisions with silicon atoms along the way. It is the energy-robbing collisions with silicon atoms that limit the electron velocity in longer-channel transistors. Higher velocity of travel enables the transistor to switch faster. IBM researchers have achieved switching speeds of a hundred-billionth of a second in transistors of 0.1 micrometer channel length. This is about 20 times as fast as devices of 0.75 micrometer channel length. While some characteristics of transistors get worse and new problems arise as channel lengths shrink below about 0.4 micrometer, certain other problems, such as "hot electron damage," which seriously limits the life of transistors, actually diminish as channel length is reduced below 0.15 micrometer.

However, once the size of transistors shrinks below about 0.1 micrometer, their effectiveness begins to deteriorate beyond any hope of salvaging. This is because the electric field between source and drain interferes with the control of the gate. The transistor's essential virtue as a switch is lost. Moreover, the other parts of the transistor—the source, the drain, and the interconnecting wiring—cannot shrink in proportion to the gate and channel length because their electrical resistance would increase rapidly, causing delays, heat, and even disintegration of the wiring itself.



3 *An "electron waveguide" is formed when electrons are confined to such a narrow channel that they can travel in only one dimension, along its length. Although the waveguide has no practical function, it allows researchers to observe the wave-like behavior of electrons.*

To construct an array of waveguides, a modulation-doped layer of AlGaAs is applied to a GaAs substrate, confining electrons to the interface between the two materials. Then channels about 85 nanometers (billionths of a meter) wide and 20 nanometers deep are etched in the AlGaAs. Surface charges and atomic-level defects on the etched areas push electrons at the interface to either side, restricting them to channels only 30 nanometers wide. Raising the voltage on the metal "back gate" attached to the bottom of the substrate adds electrons to the channels.

Thus, in the next decade or two either we will see the end of the electronics revolution as we know it, or we will plunge ahead on an even more exotic and revolutionary quest to exploit quantum-effect electronics using structures that approach the size of large molecules.

Electron Waveguides

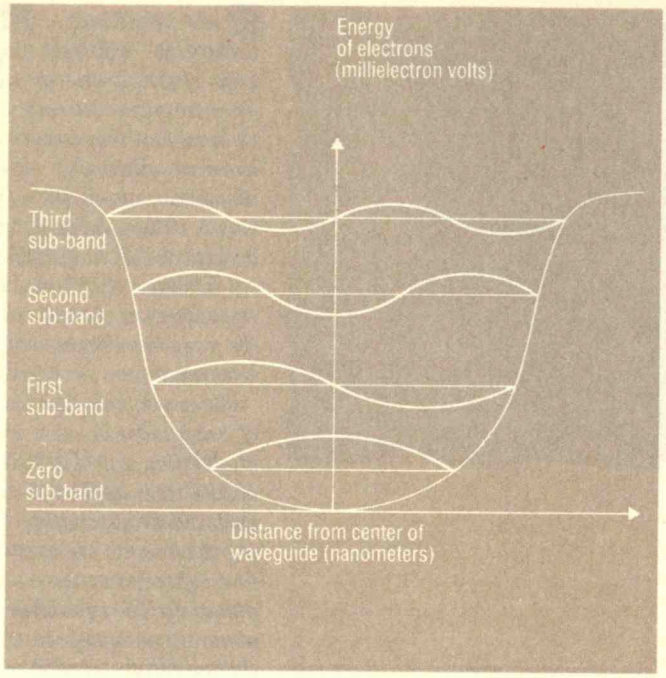
The simplest quantum-effect structure is a "quantum wire" or an "electron waveguide." Electrons are confined to a narrow enough channel of a semiconductor that they can travel in only one dimension, along its length. We examine electron waveguides not as devices with practical applications, but as structures that allow us to observe the wave-like behavior of electrons predicted by quantum theory.

To create an electron waveguide, we first grow a layer of the semiconductor aluminum gallium arsenide (AlGaAs) on top of a substrate of gallium arsenide (GaAs). (*See figure 2.*) The two materials form a continuous single crystal—that is, the arrangement of atoms is perfectly regular, without any misfit or defects at the interface of the two layers. This is possible because the distance between atoms in AlGaAs matches that in GaAs.

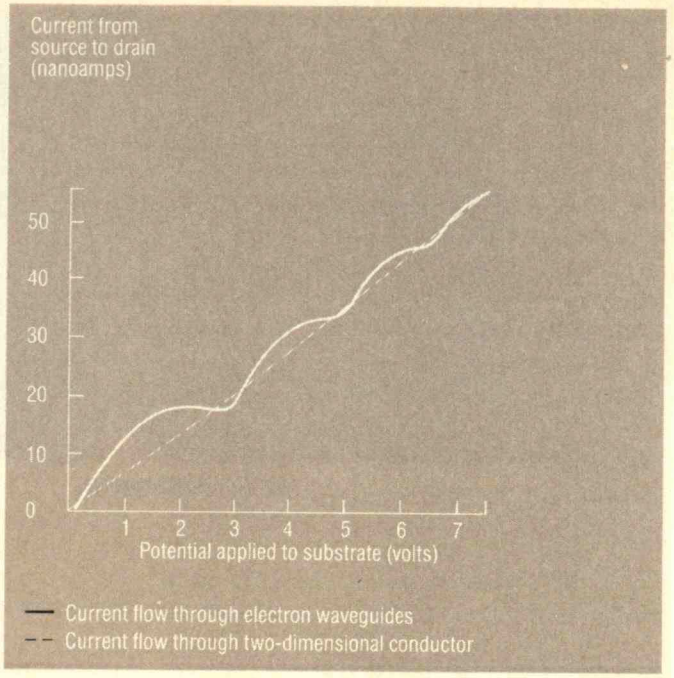
However, the chemical composition of the two materials differs, which causes a sharp drop in the energy of an electron at the interface. As a result, electrons move from the AlGaAs to the GaAs. The AlGaAs away from the interface is "modulation doped" with impurity atoms that have an extra electron in their outer shells. These extra electrons enter the GaAs, leaving behind positively charged ions in the AlGaAs. The positive charge of the ions pulls the electrons in the GaAs strongly to the interface. There they are confined in a "potential well": they cannot readily move away from the interface, but they are totally free to move in the plane of the interface. This is called a "two-dimensional electron gas."

Because the electrons at the interface are well separated from the charged dopant ions, they can travel distances that, for semiconductor devices, are quite long—a few thousand nanometers —without scattering. By contrast, electrons in silicon can travel only a few tens of nanometers before scattering. The distance an electron trav-

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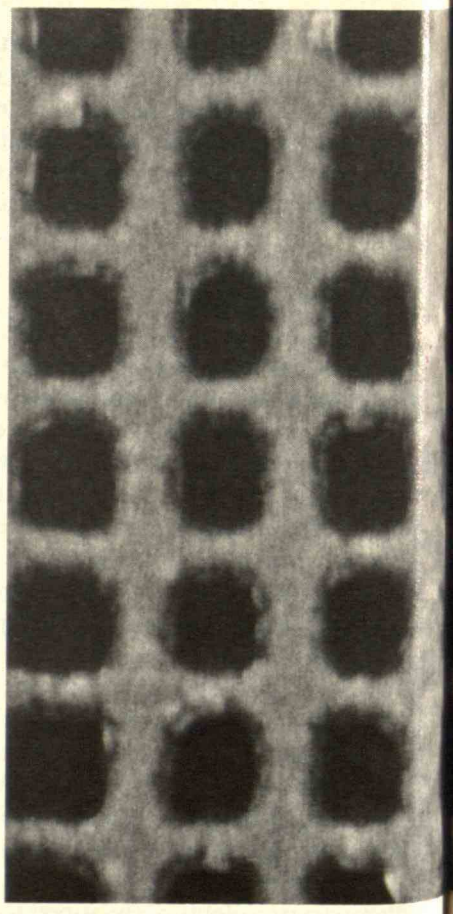
4 *As voltage is increased on the back gate, electrons are added to a waveguide (illustrated in figure 3). Only two electrons in a given space can have the same energy, so as the electrons come in, each pair must occupy increasingly higher energy levels.*

In the zero "sub-band," electron waves are directed along the axis of the waveguide. Eventually, the energy of the electrons is raised above a threshold known as the bottom of the first sub-band. Electron waves can, in effect, choose between the straight path down the waveguide in the zero sub-band and a zig-zag path in the first sub-band. When the energy of the electrons crosses the bottom of the second sub-band, they can choose to follow a zig-zag path with more turns in it. Higher energy thresholds mark the bottoms of subsequent sub-bands.

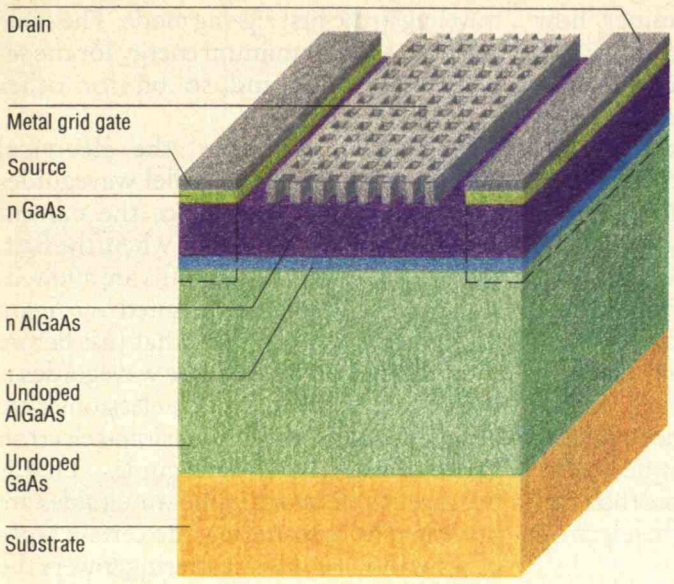
The bottom of each sub-band occurs when an integral number of half-wavelengths of electrons fit across the waveguide. One half electron wavelength fits across the waveguide in the zero sub-band, a full wavelength fits across at the bottom of the first sub-band, and so on.

5 *If electrons were added to a two-dimensional electron gas—that is, if they were not confined in waveguides—the current would increase steadily, as the dotted line indicates. However, for electrons restricted to waveguides, the current should drop at the second, third, and fourth sub-band thresholds, according to quantum theory. Researchers at the Submicron Structures Laboratory have observed this quantum effect. Note that before the dips, current in the waveguides is higher than in a two-dimensional electron gas. That is because the electrons are restricted from scattering into certain types of wave motion. Less scattering increases electrical conductivity.*

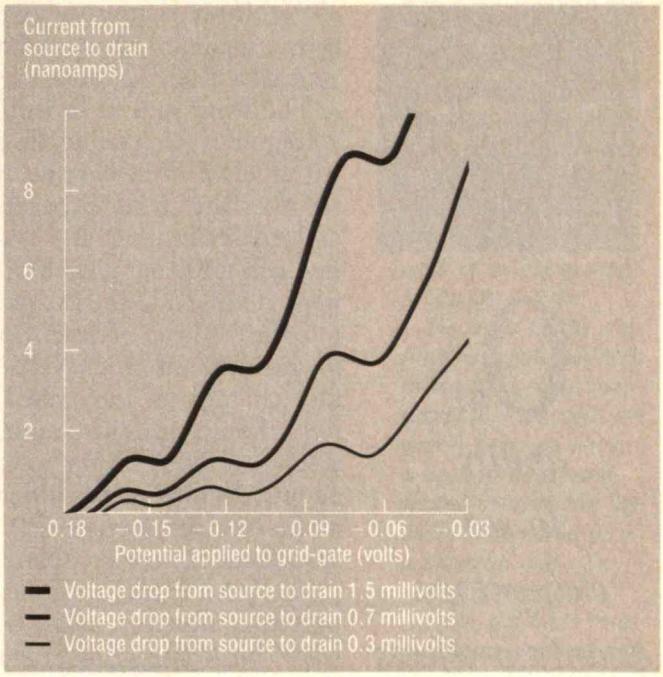
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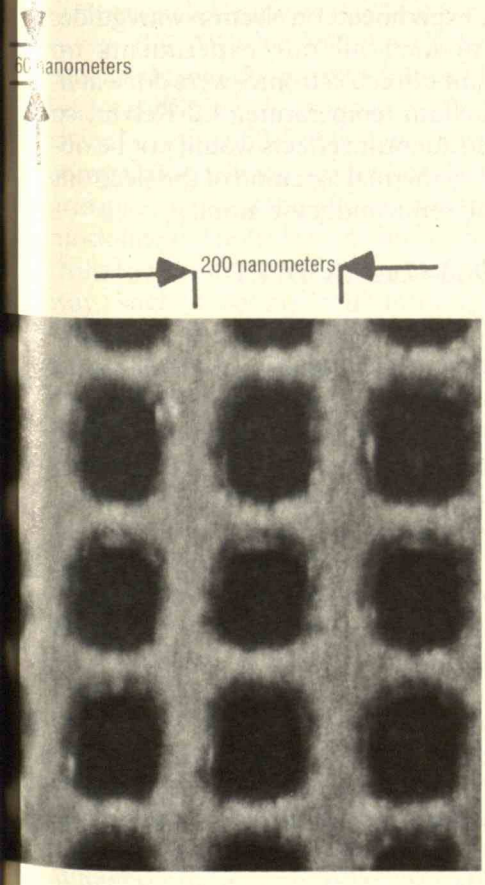


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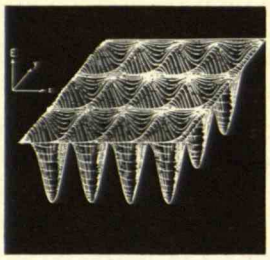
6 *The grid-gate MODFET (modulation-doped field-effect transistor) is modulation doped like an electron waveguide but functions somewhat like a transistor. A small drop in potential between the source and the drain allows a current to flow along the interface between the AlGaAs and the GaAs, and changing the potential on the metal "grid gate" can modulate this current. (Potential is measured in volts. In this case, the drop between source and drain is around one-thousandth of a volt.) The grid-gate MODFET demonstrates more complex quantum effects than the waveguide.*

A small negative potential applied to the grid gate decreases the "depth" of the potential well underneath the lines of the grid. That is, the negative voltage tends to counter some of the positive charge of the ions in the AlGaAs that attract electrons to the interface. The depth of the potential well is modulated periodically, repeating every 200 nanometers along with the metal grid itself.

With the electrons flowing from source to drain, the potential on the grid gate of the MODFET rises from −0.18 volts toward zero. This preserves the periodic modulation of the potential well but increases its average depth. As more electrons are attracted to the interface, they assume higher energy levels and hence a shorter wavelength. Whenever the 200-nanometer period of the potential well is an integral multiple of half the electrons' wavelength, the electrons should be diffracted back, and there should be a dip in the current.

7 *Researchers at the Submicron Structures Laboratory have observed the predicted dips in the current flowing through a grid-gate MODFET, confirming this wave-like behavior of electrons.*

8 *Electron micrograph of the grid gate.*



Our ability to see elementary quantum effects provides motivation to investigate practical devices.

els without scattering determines how clearly quantum effects will stand out when we make electrical measurements.

The final step in creating an electron waveguide is to confine the electrons to an extremely narrow channel in the plane of the interface. In one experiment our group created devices with 100 of these channels by etching 100 parallel lines, each about 85 nanometers wide and 20 nanometers deep, into the top layer of the AlGaAS. The etching produces atomic-level defects and surface charges on the etched areas, which push the electrons at the interface to either side, restricting them to channels only about 30 nanometers—little more than 100 atoms—wide (*see figure 3*). The electron waveguide is now complete.

To look for the wave-like behavior expected of electrons in the waveguides, we use a "back gate" that allows us to control the number of electrons at the GaAs/AlGaAs interface by means of the voltage applied to it. As the voltage on the back gate is raised, electrons are added to the waveguides. New electrons must occupy increasingly higher energy levels. This is because of the Pauli exclusion principle, which ensures that only two electrons in a given space can have the same energy.

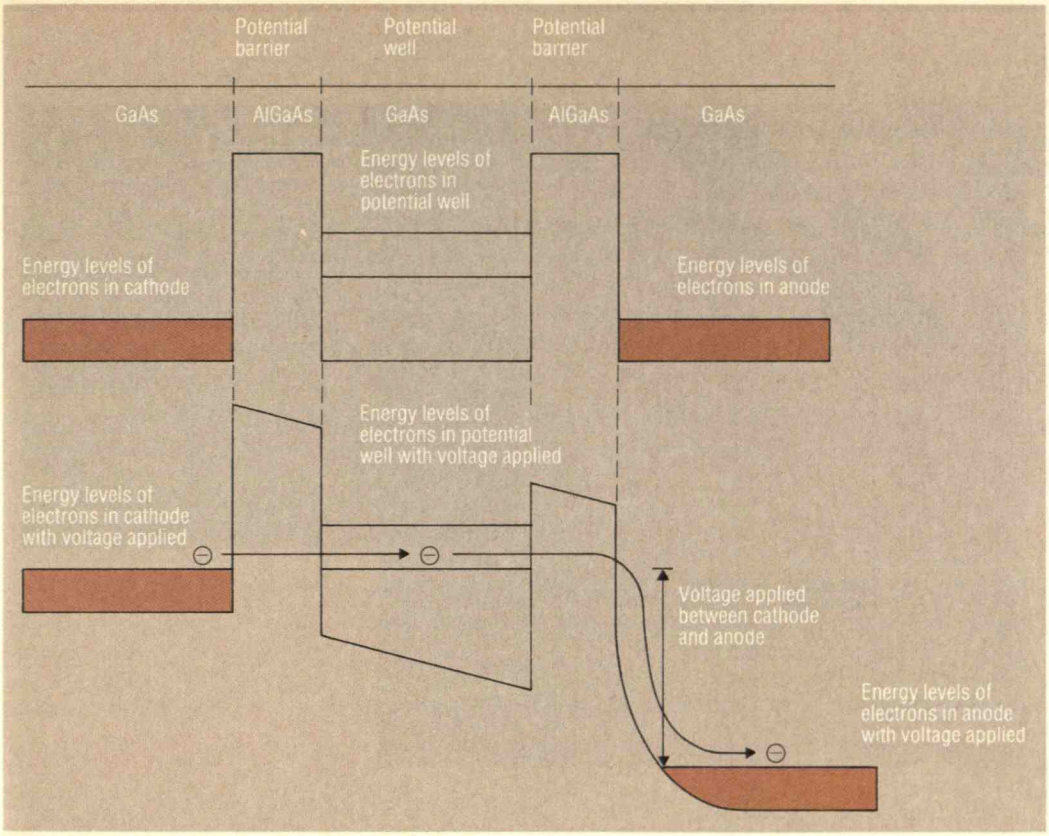
One can imagine electron waves traveling in different modes down the waveguide. In the zero mode, or "sub-band," all electron waves travel directly along the axis of the waveguide. The first sub-band contains electron waves that travel in one zig-zag path down the guide, the second sub-band contains electron waves that travel in a zig-zag path with more turns in it, and so on. There is a lowest energy for electrons that can travel in each sub-band. These energies correspond to electron wavelengths that "fit" across the waveguide: that for the zero sub-band corresponds to one half wavelength, that for the first sub-band to two half wavelengths, that for the second sub-band to three half wavelengths, and so on. (*See figure 4.*) Once the energy of electrons added to the waveguide is above the minimum needed for the first sub-band, the electron waves have a choice of continuing straight down the guide in the zero sub-band or entering the first sub-band and traveling in the first zig-zag mode. The same happens at the minimum energy for the second sub-band, and so on for other sub-bands.

According to theory, the electrical resistance of the 100 parallel waveguides should increase, and hence the current should drop, at those points where the first, second, and third zig-zag paths are allowed. This is what our group measured (*see figure 5*). It is also worth noting that just before these dips, the current in the waveguides is higher than it would be if the electrons were in a comparable two-dimensional electron gas, not restricted to waveguides. That is because the electrons in the waveguides are prevented from scattering into certain types of wave motion. Less scattering lowers the electrical resistance. This is also an expected quantum mechanical behavior that is reassuring to observe. Our ability to see such elementary quantum effects provides motivation to pursue more subtle effects, and ultimately to investigate devices of practical importance.

The experiments on electron waveguides and, in fact, all our experiments on quantum-effect electronics were done at liquid helium temperature, 4.2 Kelvin, so that the quantum effects would not be obscured by thermal agitation of the electrons and the semiconductor atoms.

The Grid-Gate MODFET

Another type of structure, the grid-gate MODFET, has allowed us to observe a more complex quantum effect known as back diffraction. The term MODFET stands for "modulation-doped field-effect transistor." The substrate consists of a layer of modulation-doped AlGaAs on GaAs, as in the waveguide, but the grid-gate MODFET is somewhat like a conventional transistor: it has a source, a drain, and a "grid gate" to which a positive or negative voltage can be applied. The metal conductors that comprise the grid are only 60 nanometers—fewer than 600 atoms—wide. They form a lattice of squares, each 200 nanometers from the center of one side to the center of the next. (*See figures 6 and 8.*)



9 *When confined to a small space, a wave can reflect back and forth between the walls in what is known as a standing wave. For example, sound waves of particular frequencies reflect from opposite walls of an organ pipe, producing a tone.*

Electrons can be confined in a potential well in much the same way, except that the walls are energy barriers. Above: a layer of GaAs sandwiched between two layers of AlGaAs can form a potential well—the energy drop between AlGaAs and GaAs tends to confine electrons in the GaAs. When the well is narrow enough, electrons in it can form several standing waves, each with a different wavelength and energy level.

Below: when a voltage is applied between the cathode (negative terminal) and the anode (positive terminal), the energy levels of the whole structure tilt. Energy levels of electrons in the well can be brought into alignment with the highest energy level of electrons in the cathode. That is, the wavelength of free electrons in the cathode is the same as that of electrons in one of the standing waves. Then electrons can pass, or "tunnel," through the well and contribute to a current in the anode.

As in the waveguide, there is a two-dimensional electron gas at the interface between the AlGaAs and the GaAs. The potential from the positive ions in the AlGaAs confining electrons to the interface is on the order of 0.5 volt. Thus, a roughly comparable voltage applied to the metal grid gate on top of the AlGaAs will strongly modulate the potential confining the electrons to the interface. Or, to put it another way, such a voltage will modulate the "depth" of the potential well at the interface. The depth of the well will increase and decrease periodically, in a manner that repeats every 200 nanometers along with the metal grid.

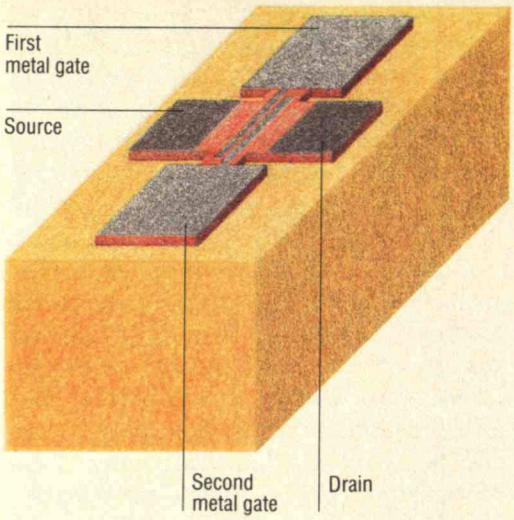
We apply a small potential difference between the source and the drain, so electrons flow along the interface. Now we begin to increase the potential on the gate and hence the average potential attracting electrons to the interface. If the gate were a uniform conductor and not a grid, the current (or flow of electrons) from source to drain would increase smoothly. But since the gate is a grid, additional phenomena come into play. The added electrons assume higher energy levels and hence shorter wavelengths. Whenever the grid period of 200 nanometers is an integral multiple of half their wavelength, these electrons will diffract back. Indeed, we have observed such diffraction: the electron flow from source to drain drops at gate voltages corresponding to these wavelengths. (*See figure 7.*)

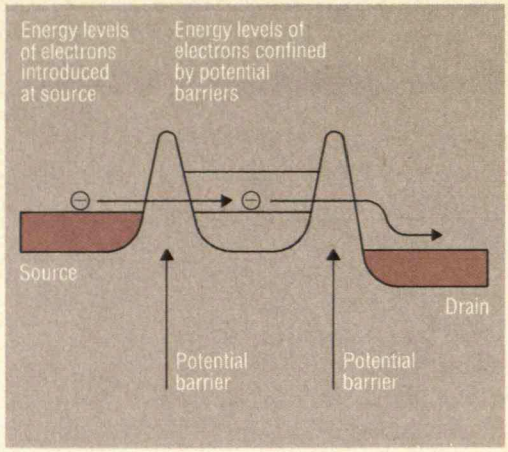
The PRESTFET

The reader might ask: What does the grid-gate MODFET do? What is its practical function? Our answers would be "nothing" and "none." We worked on this device to see if we could actually make it and if it behaved as theory said it should. However, another property of waves known as resonance makes it possible to construct a device that can function as a quantum-effect switch, akin to a transistor.

Resonance is fundamental to all wave motion. When a wave is confined to a small space, it tends to reflect back and forth between the walls creating what is known as a "standing wave." For example, sound waves reflected from opposite walls of an organ pipe reinforce rather than cancel out one another. The tone produced by an organ pipe corresponds to the standing wave or resonance.

10





10 ***A PRESTFET (planar-resonant-tunneling field-effect transistor) is essentially a quantum-effect transistor. It switches a current on or off by exploiting the wave-like behavior of electrons confined in a small space.***

As in the waveguides and MODFET, a two-dimensional electron gas is created by a modulation-doped layer of AlGaAs on top of a layer of GaAs. Left: A potential of about zero volts applied to the two metal wires or gates creates potential barriers underneath them at the interface of the materials. Electrons are confined between the barriers in standing waves.

As the voltage on the two gates is gradually raised above zero, it reduces the force preventing passage of negatively charged electrons (recall that opposite charges attract). To put it another way, raising the voltage on the gates lowers the potential barriers. This allows more current to flow, as would occur in an ordinary transistor, but it also changes the energy levels and wavelengths of electrons that form standing waves in the well. Right: When the wavelength of the most energetic electrons in the source matches that of a standing wave in the well, the current from source to drain increases.

Electrons can be confined in a potential well much as sound waves are in an organ pipe. Only instead of having walls of metal or wood, the walls of the potential well are energy barriers. When the width of the well is narrow enough so that the electron forms a standing wave, a phenomenon known as resonant tunneling becomes possible. If the energy of free electrons in the source (cathode) aligns with one of the energy levels in the well, electrons from the source can pass directly through the left potential barrier, the well, and the right barrier, and contribute to a current in the drain (anode). Another way of saying this is that transmission occurs only for electrons whose wavelengths are such that a standing wave, or resonance, is built up in the well as the electron wave reflects back and forth between the barriers.

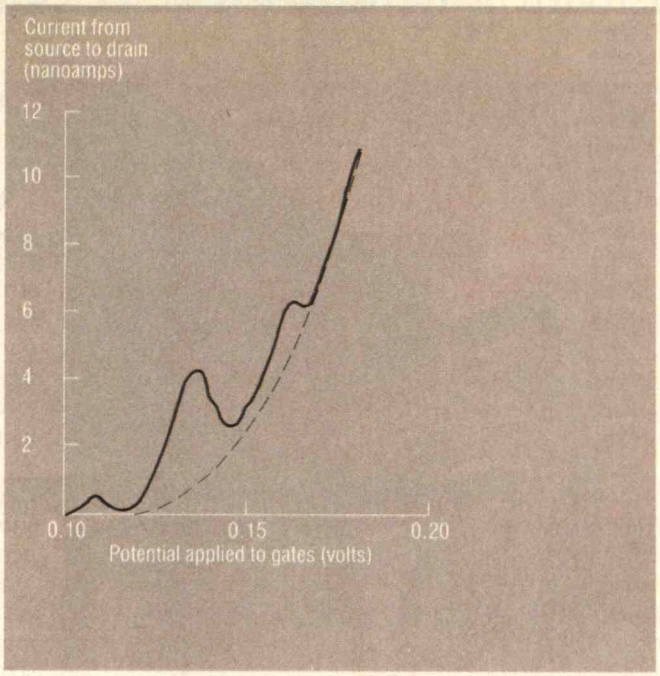
Thus, by controlling either the energy levels in the well or the energy of electrons introduced at the source, it should be possible to control the flow of electrons from source to drain. The device should function as a switch, "turning on" at well-defined points as the conditions resonant tunneling are met.

Researchers have known about resonant tunneling for many years and have appreciated its possibilities for use in an electronic device analogous to the transistor. But it wasn't until 1984 that a team at MIT's Lincoln Laboratory, led by T.C.L. Gerhard Sollner, first demonstrated the phenomenon in practice by means of the "resonant tunneling diode." The resonant structure was basically a sandwich of two AlGaAs barriers about 5 nanometers thick with a 5-nanometer well of GaAs in between. (*See figure 9.*) Since then, scientists throughout the world have studied resonant tunneling, using the same design but often with improved semiconductor materials.

However, the sandwich configuration has many limitations. For one, trying to create a standing wave between the barriers is akin to trying to produce an organ tone between two flat plates. It doesn't work too well. And it is difficult to attach an electrode to the well layer, which is necessary if we are to construct a device similar to a transistor, which must have three terminals. To overcome these problems, our group recently developed a different design called the planar-resonant-tunneling field-effect transistor, or PRESTFET (*see figure 10*).

The PRESTFET functions somewhat

11



11 *The dotted line shows the increase in current from source to drain that would occur if a PRESTFET were an ordinary transistor, not specifically exploiting quantum effects. When the wavelength of an electron standing wave in the PRESTFET's potential well matches the wavelength of the most energetic electron in the source, there is a surge of current as electrons tunnel through the well. The solid line shows these current increases resulting from quantum effects. Exploiting such surges is the key to the operation of quantum-tunneling transistors like the PRESTFET.*

like a transistor switch: it passes current when the resonance conditions are met and shuts off current when they are not. Like the waveguides and grid-gate MODFET, it has a modulation-doped AlGaAs layer on top of GaAs. When a potential of zero volts is applied to the two metal wires or gates on top of the AlGaAs, potential barriers are created directly under them at the interface: the two-dimensional electron gas that is normally located at the interface is forced away beneath the barriers. As a result, the electrons at the interface between the two wires are confined, somewhat as sound waves are confined by the walls of an organ pipe.

As we gradually raise the voltage of the two gate wires above zero, we lower the potential barriers. To put it another way, we reduce the force repelling the negatively charged electrons (recall that opposite charges attract). This changes the energy levels of the resonances in the well. When the wavelength corresponding to a resonance matches the wavelength of the most energetic electrons on the source side of the barrier, we see a sudden increase in current from source to drain. Electrons tunnel from the source side,through the first barrier, through the well, and through the second barrier into the drain. Further raising the gate voltage takes us out of the resonance conditions until the next resonance meets the condition for tunneling. (*See figure 11.*)

In the first PRESTFET, the gate wires and their separation were 60 nanometers across. Unlike conventional transistors, the PRESTFET's performance should improve as we make the gates finer. Finer wells and barriers would make the resonances sharper and more separated in energy, and thus make a better switch. Also, the switching would improve if the electrons were confined in box-like potential wells, or "quantum dots." The optimal minimum feature sizes for a PRESTFET are probably about 10 to 30 nanometers, a large reduction from the 500 nanometers of present conventional devices.

A New Approach to System Design

These experimental devices are a first step toward developing the technologies and ideas that may lead to circuits and computation systems based on quantum-effect

(*Continued on page 40*)

Fabricating Quantum-Effect Devices



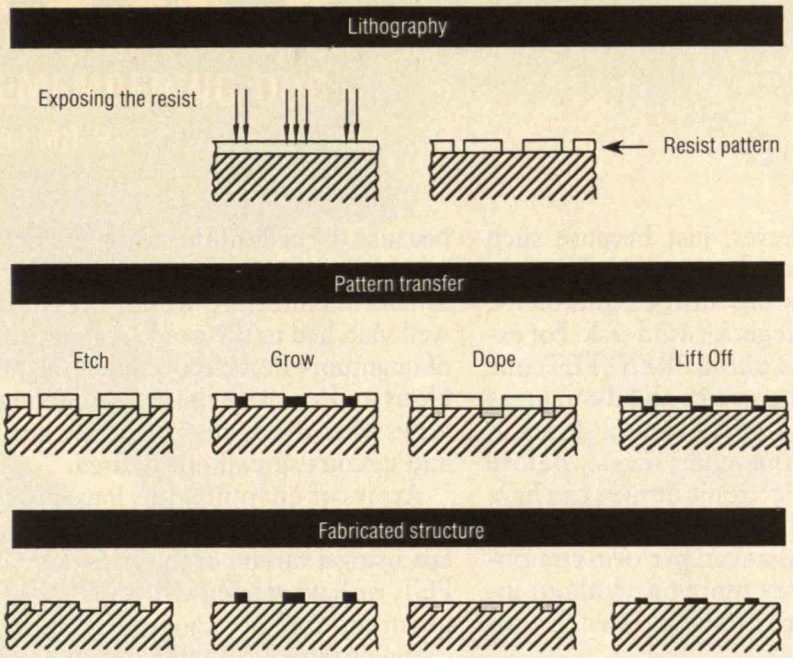
A researcher at the Submicron Structures Laboratory.

CONCEIVING quantum-effect experiments that exploit the wave-like properties of electrons and performing measurements are relatively easy compared with fabricating the necessary nanostructures. Techniques for growing high-quality single-crystal semiconductor layers and fabricating structures with features smaller than 100 nanometers (or billionths of a meter)—so-called nanofabrication—are vital ingredients of quantum-effect electronics. In fact, fabrication consumes most of the time, effort, and expense devoted to such research.

The basic approach to nanofabrication is similar to that used in integrated-circuit fabrication: a substrate is coated with a radiation-sensitive film known as "resist" (usually, but not always, a polymer) and exposed to a pattern of radiation, which can be electrons, ions, ultraviolet photons, or x-rays. The pattern can be defined by scanning a pencil-like beam of the radiation over the surface, projecting an image through a lens, or passing the radiation through a mask in which certain regions are blocked and others are transparent. The resist is altered chemically so that exposed regions can be selectively dissolved away, leaving a relief pattern on the substrate. Then the substrate itself is altered by some combination of techniques. These include etching areas unprotected by the resist, implanting ions into such areas, growing a second material through openings in the resist, or depositing a second material on the entire surface and dissolving the remaining resist to lift off material not in contact with the substrate.

This simple procedure is used to produce conventional electronic devices with features many micrometers (or millionths of a meter) across, as well as quantum-effect devices with features approaching 10 nanometers. For quantum-effect structures, it is necessary to use short-wavelength radiation (with wavelengths of less than 5 nanometers) such as x-rays,

PHOTOGRAPH: BARRY HETHERINGTON



A basic method for fabricating semiconducting devices and other electronic structures is lithography (left). A photosensitive film known as "resist" (usually a polymer) is applied to the substrate and exposed to a pattern of radiation. Ultraviolet light is used for conventional integrated circuits, but forms of short-wavelength radiation such as x-rays are used for nanostructures with feature sizes approaching 10 nanometers. A mask of a material like gold or tungsten absorbs the radiation in selected areas while allowing it to expose the resist elsewhere. Exposed regions are dissolved away, leaving a pattern of resist on the substrate.

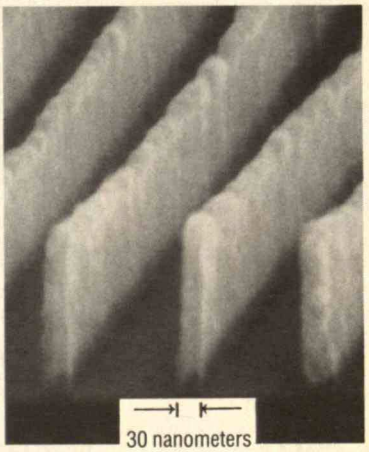
Several processes can then be used to fabricate the semiconducting device or structure. Areas unprotected by the resist can be etched, or a second material can be grown on them. Ions can be implanted into the substrate in unprotected areas to dope them. Finally, another material can be deposited on the entire surface. Then the resist can be dissolved, lifting off material that is not directly on the substrate.

electrons, or ions, rather than ultraviolet light (with a wavelength of about 300 nanometers), which is used in fabricating conventional devices.

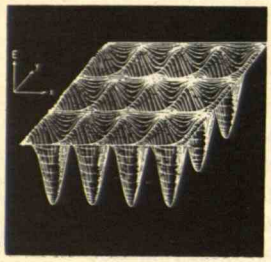
Electrons and ions can be focused into fine beams with diameters of 10 nanometers or even less and used to create nearly any pattern in a resist, much as one would draw a sketch dot by dot. The process is completely computer-controlled and at first glance would appear to be the perfect solution. However, there are a number of serious technological difficulties. One is that the time needed to expose a pattern in this way becomes inordinately long as feature sizes decrease. Creating a pattern of 10 billion quantum dots over an area of one square centimeter could take many days. Electron-beam or ion-beam systems cost $2 million or more, so tying one up for such long exposure times is beyond the realm of practicality.

In our research, we have chosen a different strategy—x-ray nanolithography, which is akin to printing an entire page from one master plate rather than writing the text out dot by dot. First, a pattern is created on a mask, using an x-ray absorbing material such as gold or tungsten. Then the pattern is replicated in the resist by illuminating the mask with a parallel beam of "soft" x-rays (so called because they have too little energy to penetrate even the outer layer of human skin).

X-ray nanolithography produces astonishing results. For example, we have produced resist lines on a silicon substrate that are only 30 nanometers wide. X-ray masks can be used over and over, and the laboratory equipment we need to expose patterns with them costs only about $20,000—very economical by modern standards. Because x-ray nanolithography is a parallel rather than a serial process, exposure time can be a matter of seconds if x-ray sources suitable for mass production are used. Thus, x-ray nanolithography is compatible with both our current research, where we are interested in fabricating extremely narrow lines by a simple, low-cost process, and future manufacturing, where we will need high volume and reliability. In the Submicron Structures Laboratory we are perfecting the mask technology and developing means to align masks and substrates with an accuracy of less than 10 nanometers. That way x-ray nanolithography will be ready when the need to manufacture quantum-effect electronic systems arrives. ■



Above: the Submicron Structures Lab has used x-ray nanolithography to create a pattern of resist with lines only 30 nanometers wide.



We must invent circuits that can perform computation without interconnecting each switch with metal wiring.

electronics. However, just because such small devices have been made does not mean that fabricating entire circuits on the same scale is a straightforward task. For example, in the case of the PRESTFET, one obstacle is that the source and drain areas and the gate contact pads cannot shrink in proportion to the gate wires. Before quantum-effect electronic devices can have practical applications, we must invent new kinds of circuits that can perform computation and memory functions without interconnecting each individual switch with metal wiring.

One possibility goes back to an idea proposed by the mathematician John Von Neumann, who in the 1940s originated the conventional computer architecture, as well as a computer based on the principle of "cellular automata." Conventional computers operate by taking a number from a memory, adding it to a number already located in a register of the processor, and then putting the result back into the memory. Generally, only one such operation is being performed at any one time, but because it is being done so rapidly (close to a billion times per second in modern supercomputers) the cumulative effect is enormous. The marvelous things that computers do for us in everyday life depend on the software placing an interpretation upon the simple arithmetic function of adding two numbers. At any given instant, a large fraction of the electronics of a conventional computer are idle.

In contrast, a cellular automata computer consists of an array of cells or "devices," each of which interacts only with its near neighbors. Information is put into the array and then processed by allowing the cells to switch in accordance with a simple preordained set of rules. It is well known by computer scientists that general-purpose computation can be done in this way. Also, because the cells of the array interact only with their near neighbors, the cellular automata architecture would appear to be well matched to the needs and limitations of quantum-effect electronics. It might enable us to circumvent the crisis of wiring that arises when the number of devices gets large and circuits spread out in area.

Arrays of quantum dots have been proposed as cellular automata arrays. In our lab, using a variant of the grid-gate MODFET, we have created arrays of 200 million quantum dots per square centimeter. By changing the voltage on the grid gate we can adjust the quantized energy levels in the dots and the strength of interaction between adjacent dots. We can establish conditions so that on the average each dot contains only a few (perhaps six) electrons. Information could be encoded—for example, by assigning the value 1 if a dot contains an odd number of electrons and the value 0 if it contains an even number of electrons. We have some ideas for how to allow neighbors to interact, but at present do not know how to actually build a computing function based on coupled quantum dots.

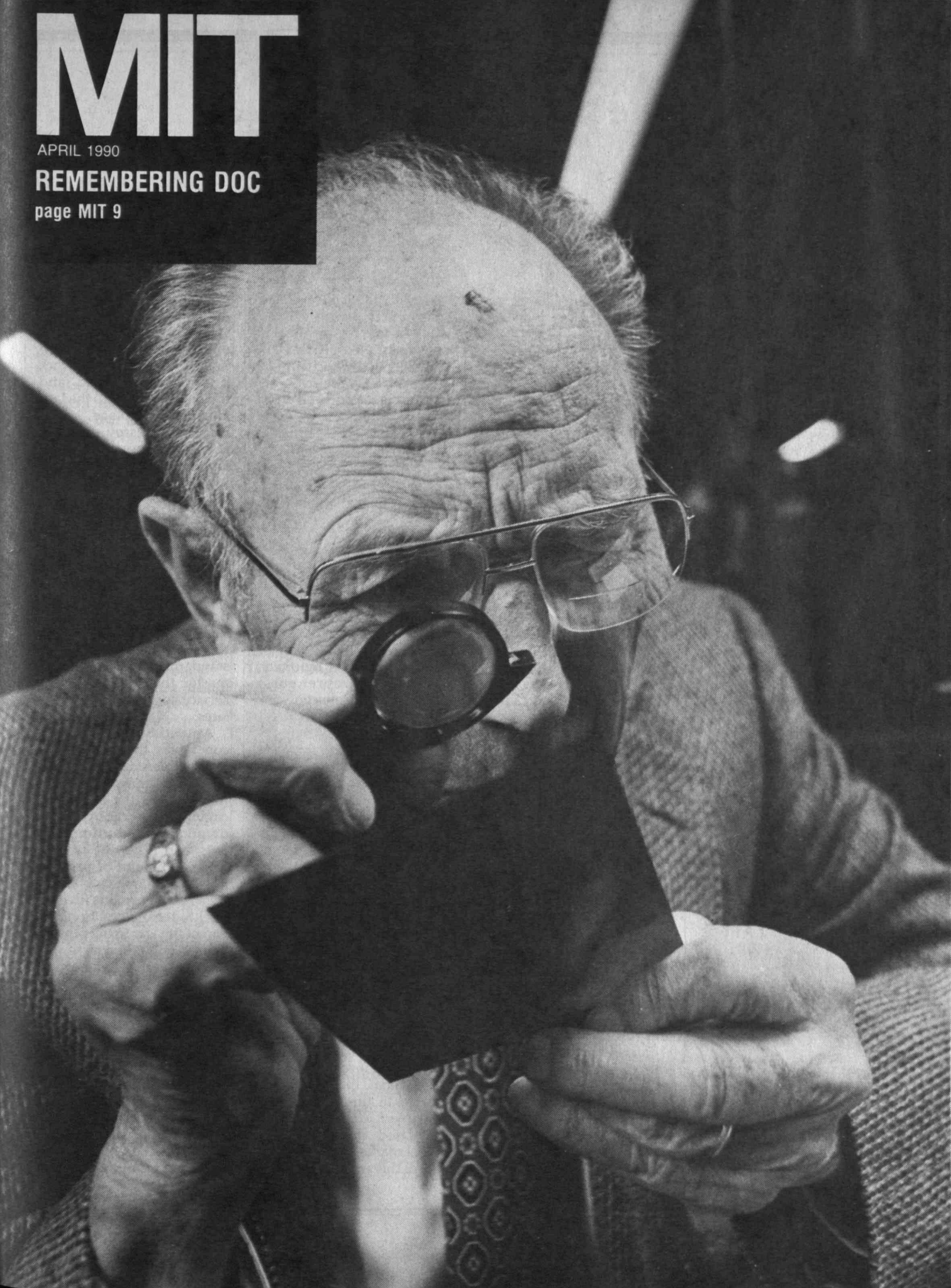
Thus, future progress in quantum-effect electronics must include research along three parallel paths. First, we need to continue developing the materials and fabrication technology, aiming at structures with minimum features of 10 nanometers. Second, we must study the basic physical phenomena observed in artificial nanostructures. And third, we have to try to invent means of performing computations with arrays of quantum-effect devices. All three paths represent welcome but difficult challenges. Even the most optimistic observers agree that we will be well into the twenty-first century before computers based on quantum-effect electronics will appear and provide performance consistent with their promise. ■

MIT

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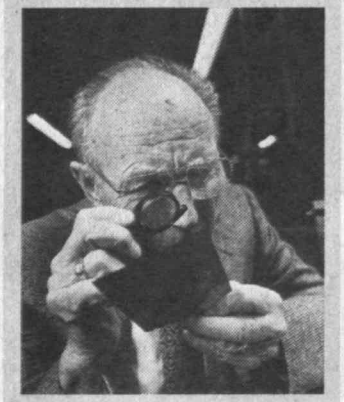
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COVER:
The eyes that looked out on the world with such curiosity, creativity, and infectious delight are closed, but Doc's vision is his legacy to us all. Photo: J.D. Sloan

The Enterprise Forum and the Global Economy

The time for fearing a foreign takeover of U.S. business sectors has passed. Japanese electronics products are here—and everywhere else. So are Korean, Taiwanese, and German products, amid many others, and they are often among the highest quality on the market. Foreign-based companies have moved into both the U.S. consumer and industrial markets, and are here to stay.

Now it's time to do something about it. The most obvious counterattack is for U.S businesses to intensify their presence overseas, especially in the countries that have been most successful in exporting their products here.

In the 1990s, being a global competitor will be as much a fact of building a business as mergers and acquisitions and leveraged buyouts were in the '80s. And not just for large multinationals, but for startups and small companies as well, particularly those in high technology and manufacturing.

Such were the themes of the 10th annual entrepreneurial workshop sponsored by the MIT Enterprise Forum of Cambridge last October. The Forum operates under the aegis of the Alumni/ae Association.

Indeed, the United States is in very serious trouble vis-a-vis its industrial performance," Michael Dertouzos, PhD '64, chairman of the MIT Commission on Industrial Productivity, states flatly. "And if we don't mend our ways, we will suffer in terms of our relative standard of living. We will be impoverished [compared with] countries that are doing better than we are."

Last May, the commission published its report in a book called *Made in America: Regaining the Productive Edge* (MIT Press, 1989), which found six real weaknesses in U.S. industry. Only half of those, Dertouzos reported, apply to entrepreneurs: short time horizons; government and industry working at cross purposes so that, for example, young companies easily become overwhelmed with filing reports for exports; and most important, the inability to go from innovation to production.

"Invention is not the problem," he says. "We're still the greatest inventors in the world. DEC, Apple, Sun, Apollo have all been great startups. There are very few countries where there is as active entrepreneurship as here. There is only a small amount in Europe or Japan."

Skilled at producing, marketing, and selling, however, Japanese companies have taken the inventions created in the U.S., manufactured them, and launched them into the global market.

"All this wonderful entrepreneurial spirit we have in the United States, the marvelous spin-offs, the start-ups that create new technology—they need to work it through to the end, and they need to get into the Japanese marketplace," says Joseph A. Massey, assistant U.S. trade representative for Japan and China.

What often happens instead is that R&D start-ups are persuaded to license their technology to Japanese companies, rather than export it or manufacture it overseas themselves. The Americans are told that the product is too expensive, or they couldn't manufacture it to meet Japanese quality standards, or they couldn't master the local sales and service customs, Massey relates.

And it's not just small companies that are subject to this pressure. Bell Labs licensed the transistor; Texas Instruments, the integrated circuit; IBM, some of its fundamental computing patents; and RCA, the patents for the low end of its market—all in what Massey calls "the enormous fire sale of U.S. technology from the end of the war to the present day." Today, of course, the Japanese are selling products based on these patents back to us to the tune of a $55 billion trade deficit.

"Those technologies are the key to our national future, the employment opportunities our children will have, the growth of our wealth and technology base," Massey says. "Don't sell your children. Put [your technology] into exports. If

you license it to Japan, they're going to come back and bite you."

One entrepreneur disagreed, however. Barry Godowsky, marketing vice-president for Ventrex Laboratories Inc. in Portland, Me., said his company had benefited from licensing technology in several cases. "[In the domestic market] we've focused on diagnostic testing because of Medicare and the health insurance system," he says, "but the international markets aren't testing so much." His company has no compunction about licensing when a market is too small to develop, such as Belgium, so as not to divert attention from its U.S. focus. And in a deal with China, Ventrex licensed the know-how for a pregnancy test, which would be nearly impossible to produce, ship, and sell competitively, Godowsky says. The Chinese then pay a royalty on the final product.

Japan is 1/27th the size of the United States and has half its population. Yet it has more retail outlets than the U.S. and has become the world's largest consumer of electronic goods and the second largest consumer of nearly everything else. On the one hand, it is has successfully penetrated the U.S. market so that 96 percent of the electronics goods sold here are from Japan, 4 percent from the United States—reversing the percentages of just a few couple decades ago. And last year Japanese companies filed for more patents in the U.S. than U.S. companies did. On the other hand, it has protected itself from market incursion; for example, while the United States holds on to 80 percent of the fiber-optic market outside Japan, it has less than 1 percent inside.

Japan continues to loom as the toughest nut to crack, so several executives offer some advice.

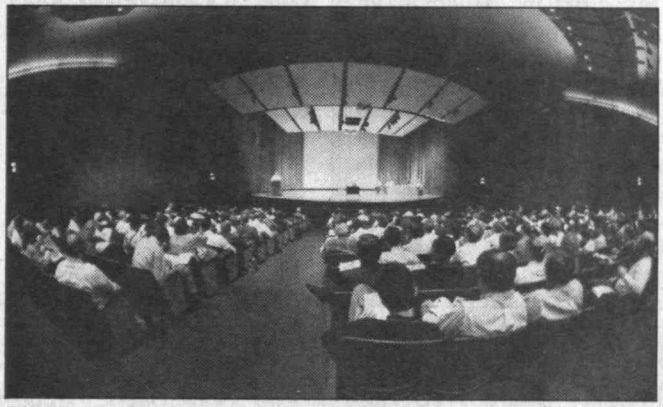
"The Japanese are very fussy," asserted Kenneth Morse, director of Aspen Technology, Inc. "Why are French restaurants better in France than they are in the U.S.? Because they have demanding customers. Likewise, the Japanese love to make a fuss, and they love to make a fuss on us, because they think [we're] lazy and the quality [of our products is] lousy. They'll yell at you if you deliver it tomorrow and not tonight, but that's good for your company. If you can make it in Japan, you can make it anywhere."

Morse suggests that entrepreneurs take their engineering staff to Japan to look around. "Then you come back and have a little meeting, and all the engineers say, 'Jeez, are they scary!' And you say, 'OK, guys, I have the MBA. I can go work in another industry. But you're stuck. So I'm going to leave you alone for a while, and you can make your own decision whether we tank the company now or whether we're going to make it in Japan.' " Morse notes, "We need their standards of productivity to push our own people."

Developing and keeping good employees is absolutely critical when working in Japan, says Bill Schneider, technology vice-president and one of the founders of MRS Technology in Chelmsford, Mass. "It can really contaminate your relationship if your senior software engineer is a different person every six months," he says. "[The Japanese] rely a lot on personal relationships, and if a key engineer is gone the next month, it's back to square one." To head off such a problem, MRS has no employee contracts, but every employee down to the janitor has equity. In three years, the company has lost



Enterprise Forum keynote speaker Patrick McGovern (left) and Lore McGovern speaking with workshop participant Charles Staples.



The workshop drew more than 500 participants to Kresge.



Panelists (left to right) Joseph Massey, Klaus Nathusius, Sheryl Handler, and Michael Dertouzos.

PHOTOS: PAULA LERNER

only three people, Schneider reports.

Furthermore, he says, senior executives must maintain a presence in Japan. "Why does MRS have its own office in Japan? You have to kick a little . . . uh . . . energy into the relationship from time to time, and there is no better way than having your own people on the site." But, he adds, the people who fix the equipment and sell it are Japanese, not American—and that's important. "We felt we had to look as Japanese as possible. We do not label the product. Our partner's name is on the product. We're in this business to get rich, not famous."

William V. Rapp, vice-president of Mitsui Nevitt Capital Corp. in New York City, capsulizes opportunities in some of the other major Asian markets this way: Korea has only a few companies at a global level, meaning a limited number of partners, but it's interested in bringing in more sophisticated technology. Investors in Taiwan have "capital coming out of their ears" and the country is interested in upgrading its light industry and medium-tech products, such as PCs and printers. Hong Kong is not a great manufacturing area, except possibly in digital watches; but it is a convenient center for regional sales, since a lot of companies have regional headquarters there.

India captured the interest of workshop speaker Quintin J. Thom, president of Siveco in Lausanne, Switzerland, for its plant automation software. "Even though India is a poor country, it's something of a superpower intellectually," he says. "It's still very stratified by the caste system, but software development is very democratic, a meritocracy, so it has sucked into it a lot of very competent people."

China is a huge market, but still a hazardous one for U.S. product developers. It has the most software piracy, no copyright law, and no patent protection for pharmaceutical and chemical products, reports U.S. Trade Representative Massey. An agreement last May between the PRC and the U.S. required the Chinese to draft intellectual property protection by April 1990, but Massey says last June's political turmoil has delayed that process.

Europe is the other major area for immediate attention from entrepreneurs. In 1992, the Single European Act of 1986 will go into effect, so U.S. companies are scrambling to establish at least a toehold before it does. "1992 is very scary for many companies," comments Burton Marmer, retail systems vice-president of Dennison Manufacturing in Framingham, Mass. "They fear a wall will go up on December 31, [1991,] and those who aren't there aren't going to be able to participate."

Europe has been moving toward a single unified market since the European Economic Community (EEC) was established in 1957. In effect, the 1986 law recognizes that the original goal of achieving harmony has evolved into the current objective of mutual recognition, reports Jay Zimmerman, a partner in the international law firm Bingham, Dana and Gould in London. The most recent agreement identified 270 measures to remove immigration and customs barriers, duplication of testing and certification, and value-added and excise taxes among the 12 member countries. Many of these have already taken place, but overall, the new European Community (EC) is behind

A Friend's Remembrance

Frank Smith, MAR '68
1942-1990

Frank Smith, MAR '68, senior regional director at the MIT Alumni Center of New York, died suddenly on January 15 at age 47. Frank, whose full name was Benjamin Franklin Smith III, was on vacation in Jamaica with his wife Gridley and other members of his family when he apparently suffered an aneurysm.

To those of us who knew and worked with Frank, there is a sense of immense shock and loss. He stood fiercely for what he believed in, and fortunately he believed in MIT. He was a man who knew quality, sought the company of those who exemplified it, promoted it himself, and engendered the support of all those who recognize it.

Working with volunteers, Frank raised the sights of the New York Center to new standards of service to alumni/ae and the Institute. His successful calendars and diverse programming attracted record numbers of members, and he was able to enlist unusual and first-rate alumni/ae leadership for center activites.

Frank brought a challenging mind and spirit to meetings of staff and volunteers alike. Few people I have met could get to the heart of a matter more quickly or directly than he.

After earning a bachelor's degree in architecture at Tulane University in 1967 and a master's degree in housing and community design at MIT in '68, Frank worked in architecture in Boston for two years before going to Spain on a Fulbright-Hays Scholarship in 1970-71. He shared a passion for Spanish art with his wife, an art historian on the faculty at Bryn Mawr College.

Frank had worked for several years as a faculty member and administrator at the University of Kansas and at Tulane, serving as the associate dean of architecture and then the director of alumni affairs at Tulane immediately prior to joining the staff of the New York Center.

We have lost a loyal alumnus, a lively colleague, and, to many of us, a valued friend. I have had the pleasure and privilege of being Frank's friend, and I ask that all who knew him do what he might ask by celebrating his life more than we mourn his death.—*Bill Hecht*, '61 □

The author is the executive vice-president of the Association of MIT Alumni and Alumnae.

schedule.

"People keep talking about Europe 1992 like it's this flashing blaze of light that's suddenly going to be there," says Judith H. Obermayer, president of Obermayer Associates in West Newton, Mass., consultants to high-tech firms on technology transfer and innovation. "But that's not the way it is at all. Europe '92 is a process that's already started and may or may not be anywhere near completion. You will still have national and cultural differences, just as we have differences between New England and California. What people accept in one place may not be acceptable in another place, even though there aren't trade barriers. There are other kinds of barriers."

U.S. businesspeople may even have an advantage because they tend to see Europe as a whole already. "[That] annoys Europeans, but it is a temporary advantage," says Rae Sedel, managing director of Russell Reynolds Associates Inc. in London, where she recruits senior line managers for European companies. She adds, however, "U.S. companies are the least international of all. They need the Euroexecutive, who speaks English and one or two other languages, has lived in more than one country, has served in more than one function, and is both flexible and mobile."

As in Japan—or any other international market—establishing a local presence in Europe is essential. Klaus Nathusius, chairman of venture capital firm GENES GMBH Venture Services in Cologne, West Germany, calls for "glocalizing." "Define your strategy in the U.S., but choose your tactics locally," he advises.

Although going global may seem an imperative, like any business decision, it *is* a choice—and one that small companies may prefer to pass up, some speakers noted. To the question of whether to go overseas, Edwin Booth, president of CADEC Systems, Inc., in Londonderry, N.H., makers of computer systems for trucks, sums up this way: "Attitude is everything. Some people can't deal with a different culture, language, and food. They feel incompetent because they can't ask for a ham sandwich or even know it's against religious law to *have* a ham sandwich. Others thrive on working with people of different cultures. If you really want it, it is possible to be successful. If not, it's nearly impossible." — *Kimberly French* □

The author is a Cambridge-based freelance writer.



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CALENDAR

April 19, 6-8pm
Farewell Reception for
Paul Gray and David Saxon
Whitney Museum
New York City
Contact: Sylvia Crone
MIT Alumni Center of N.Y.
(212)532-8181
Reservations by April 13

April 28, 8:30pm
The President's
Ball,
honoring
Paul and
Priscilla Gray
Contact:
Mary
Morrissey
(617)253-1475



May 10
AMITA Annual Meeting
Contact: Nancie Barber
(617)253-8217

June 4, 10am
Commencement



June 6-10
Alumni/ae Week, Reunions

June 8, 9am-noon
Technology Day
"Is It Getting Hotter
or What?"—a Debate
on Global Climate Change
Contact: Eliza Dame
(617)253-8230

Opening of Centennial
Celebrations, Department
of Earth, Atmospheric
and Planetary Sciences
Contact: Jane Grussing
(617)253-8241



June 30
FY90 Alumni Fund
Year Ends

All events held on the campus in Cambridge unless otherwise noted.





From left: Ernest Kawell, George Beesley, Seymour Sheinkopf, and Oswald Stewart for the Class of '39, and Noel Bartlett for the Cleveland Alumni Fund Visit Program.

Presidential Citations

Last fall at the Alumni Leadership Conference, four MIT alumni/ae organizations were honored for their outstanding contributions to the Institute. Receiving Presidential Citations were:

■ **The Class of 1939,** acknowledged as "a model 50th Reunion class. By establishing synergistic connections between fundraising and reunion planning, the 50th Reunion and Reunion Gift Committees were able to achieve record-breaking participation in both the reunion and the gift," and in the process "set new standards for dedication and energy."

■ **The Cleveland Alumni Fund Visit Program,** with Noel Bartlett, '60, at the helm, succeeded in increasing the level of giving *246 percent* over the previous year's contributions from the same group of alumni/ae and developed a pool of energetic alumni/ae leaders for the future.

■ **The MIT Club of Dallas-Fort Worth** has greatly expanded the number of successful activities available to its members over the past two years—activities that were varied, of high quality, and that elicited enthusiastic response from members.

■ **The MIT Club of Southwest Florida** has sustained a program characterized as "close-knit, familial, and welcoming," over six meetings per year, in a way that encourages large attendance and fosters strong ties with the Institute. The club covers an area from Sarasota to Naples, and holds one meeting a year in Fort Myers for the convenience of local alumni/ae. □

Productivity Roadshow

Several of the sixteen faculty members composing MIT's Commission on Productivity are currently touring half a dozen major U.S. cities to encourage debate on the results of their report.

The study, *Made in America: Regaining the Productive Edge* (MIT Press, 1989), examines the productivity of eight industrial sectors in the United States, Europe, and Japan and analyzes the competitive stance of U.S. industry in the global marketplace. The engineers, scientists, and economists on the commission outlined specific strategies for industry, labor, government, and education that will lead to a substantial improvement in American industrial performance. [*See the August/September 1989* Technology Review *cover story for an in-depth look.*]

Beginning in Seattle in late February, the traveling troupe is hosting a two-hour summary and discussion of the Commission's findings with selected local industry leaders. The cities were chosen for the size of their alumni/ae population and the prominence of one or more of the eight industries covered in the book. Included are Detroit, Chicago, Los Angeles, and San Francisco in March, Houston on April 26, and Washington, D.C., sometime in May. New York and Boston may be added later.

A year ago, Seattle alumnus Gary Schweikhardt, SM '73, proposed to the Alumni/ae Association board the idea of a roadshow to showcase in general what is going on at MIT. Then along came the Productivity Commission with a message in search of a vehicle, and the commission tour was born.

A visit to Japan by three members of the commission in January coincided with the publication of a Japanese edition of the book. The trio challenged Japan to form a non-governmental group like the MIT Commission to study Japan's own micro-economic weaknesses and strengths. A similar challenge will be made to the European Economic Community, in the belief that the increased understanding that would result "would gradually replace today's acrimony and irritation with tolerance and trust."

The paperback rights to *Made in America* were recently sold to Harper & Row, with a $9.95 version of the book expected to be available at bookstores in September. □

UNDER THE DOMES

Barco to Speak

Colombian President Virgilio Barco, '43, will address the 124th MIT commencement exercises on June 4th. Last October, the MIT Corporation approved a resolution saluting him for "his courageous leadership of Colombia during a time of formidable challenge." Barco, a member of the MIT Corporation from 1970 to 1980, has been waging war against the powerful drug cartels operating in his country.

President Paul E. Gray, '54, in expressing his pleasure in the selection of Barco as graduation speaker, said "His dedication and strength as a national leader bring honor both to his native land and to MIT. He has committed himself to the betterment of his country through more than three decades of outstanding public service in which he has combined political activity with a humanistic outlook."



Virgilio Barco

Barco was elected president of the South American country in 1986 as a candidate of the Liberal Party. He had served as ambassador to the United States from 1977 to 1980, and to the Court of St. James from 1961 to 1962. He was mayor of Bogota, the capital of Colombia, from 1966 to 1969, served on both sides of the bicameral Colombian legislature, and was both minister of agriculture and minister of public works. From 1969 to 1974, Barco was executive director of the International Bank for Reconstruction and Development (the World Bank) for Colombia, Brazil, Ecuador, the Philippines, and the Dominican Republic. His MIT degree is in civil engineering, and he is a member of the Colombian Society of Civil Engineers and a former president of the Colombian Society of Economists. □

Provost to Step Down

After five years as provost of MIT, John M. Deutch, '61, has announced that he will step down effective June 30 in order to give the next president the opportunity to name a new provost.

Removing himself as a candidate for president as well, Deutch said that he wished to return to teaching and research in physical chemistry and public policy issues. He joined the MIT faculty in 1970, and is the Karl Taylor Compton Professor of Chemistry.

President Paul E. Gray, '54, will succeed David S. Saxon, '41, as chairman of the Corporation on June 30. □

Video Awards

A videodisc produced by MIT's Athena Foreign Language Learning Project recently won two top awards in the category of interactive video materials for educational purposes.

A la rencontre de Philippe, an interactive fiction video designed to develop comprehension of authentic spoken French, received the gold medal from CINDY (Cinema and Industry) and the Mark of Excellence award from IICS (International Interactive Communications Society). The project was funded by the Annenberg/CPB Foundation. □

Summer Smorgasbord

MIT's Summer Session is in its 41st year of providing summer programs that enable professionals to keep up with developments in their fields. More than 75 courses are offered in 22 disciplines, including aero & astro (Fundamentals of Flight Simulation), electrical engineering (Techniques in High-Speed Photography and Videography), materials science and engineering (Particulate Ceramics Processing: The Future for Manufacturing), and the Japan Program (Technical Japanese for Computer Scientists and Electrical Engineers). For further information contact the Office of the Summer Session, Room E19-356, MIT, Cambridge, MA 02139. □

Nobels in Chemistry

The two men who shared the 1989 Nobel Prize in chemistry, for their discovery that RNA can act as an enzyme as well as carry genetic information, both have MIT connections. Sidney Altman, '60, professor of biology and dean of Yale College, earned a degree in physics at MIT. Thomas E. Cech, professor of biochemistry and molecular biology at the University of Colorado, Boulder, received postdoctoral training at MIT in 1978 under Professor of Biology Mary L. Pardue. The day the prize was announced, Professor Cech happened to be at MIT to address the Biology Department's Undergraduate Student Association about his RNA work. □

1990 SUMMER PROGRAMS IN HUMANITIES AND SOCIAL SCIENCES

The Myth & Reality of American Decline: Industrial, Political & Social Change
August 8 - 10 Richard Valelly
$600

The American Psyche—Origins and Elements
June 11 - 15 Bruce Mazlish
$950

Clausewitz in the Nineteenth and Twentieth Century World
July 9 - 13 David Ralston
$950

Literature and Ethical Values
August 20 - 24 Alvin C. Kibel
$950

Literary Dialogues for Executives & Managers
June 18 - 22 Michael W. Kaufman
$950

Enhancing the Tools of Personal Communication
August 13 - 17 Alan Brody
$950

Ethnomusicology: Gateway to World Music
July 30 - August 3 Stephan Erdely
$950

Jazz Changes: Perspectives on Modern Jazz 1955-1990
July 9 - 13 Mark Harvey
$950

1992: Rising US-West European Tensions
June 11 - 15 William E. Griffith
$950

Science Policy - What Is It and Who Needs It?
July 9 - 14 Leon Trilling & Carl Kaysen
$1,500

Screenwriting
June 11 - 15 Christopher Thornton
$950

Contemporary American Religious Movements
July 23 - 27 Arthur Kaledin
$950

Shakespeare: Contemporary Perspectives
July 9 - 23 Peter S. Donaldson
$950

Tradition and Innovation in Early Modern Fiction
July 16 - 23 David Thorburn
$950

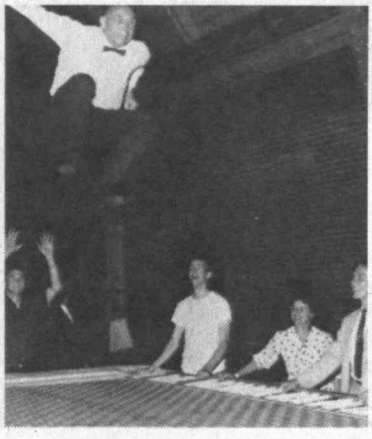
Women and Work: What Difference Does Gender Make?
July 23 - 26 Isabelle de Courtivron, Sue Carey, Ruth Perry
$800

For further information, please contact: MIT, Summer Session Office, E19-356, Cambridge, MA 02139.
Telephone 617-253-2101. Fax: 617-253-8042.

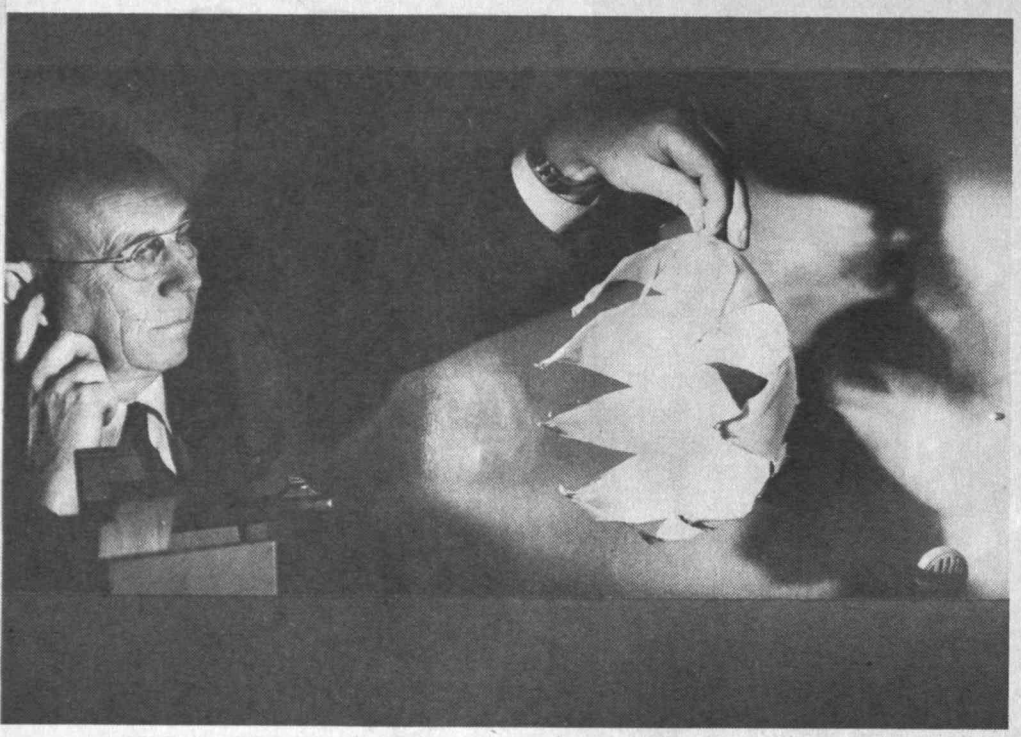
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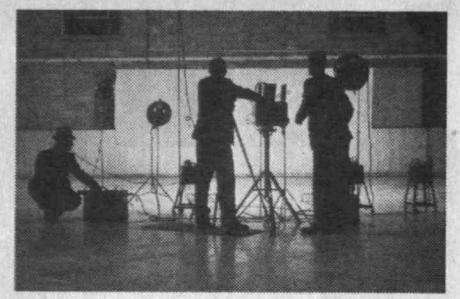
HAROLD E. EDGERTON, '27, WAS BEST KNOWN AROUND THE WORLD FOR A BRILLIANT FLASH OF LIGHT A MERE MICROSECOND LONG. BUT DOC EDGERTON WAS ALSO THE SOURCE OF ANOTHER KIND OF ILLUMINATION—THIS ONE A LONG STEADY GLOW OF 86 YEARS' DURATION. HIS WARMTH AND HUMOR, HIS CONTAGIOUS ENTHUSIASM FOR EXPLORATION, HIS GENUINE INTEREST IN PEOPLE AFFECTED DEEPLY ALL THOSE WHOSE PATHS CROSSED HIS.

A SUMMARY OF DOC'S TECHNICAL ACCOMPLISHMENTS COULD FILL MORE THAN ONE BOOK—AND HAS. HIS STROBES AND SIDE-SCAN SONARS HAVE HELPED CHANGE THE WAY WE SEE THE WORLD. BUT KNOWING DOC—OR EVEN KNOWING OF HIM—HAS ALSO HELPED US CHANGE THE WAY WE SEE OURSELVES. WHAT FOLLOWS IS AN ANECDOTAL PORTRAIT OF THE MAN BY PETER MUI, '83, A STUDENT, COLLEAGUE, AND FRIEND OF DOC'S FOR THE PAST DECADE.—Ed



PHOTOS: DOC EDGERTON 1980, PALM PRESS INC./PETER MUI/MIT MUSEUM





Doc's strobe flash produced photos such as "Self-Portrait with Balloon and Bullet" (upper left) and "Fanning the Cards" (upper right) by freezing the action at a millionth of a second or faster. High-speed multiple exposures allowed him to capture a sequence of movements in one picture, such as that of the pistol-twirling cowboy (lower left). Below, Doc is shown at a restaurant with his wife, Esther Garrett Edgerton, and his parents, Mary N. and Frank E. Edgerton. Doc's longtime technician and friend, Bill MacRoberts (lower right), was "borrowed" from the electrical engineering machine shop 47 years ago to help build the equipment Doc was designing to take nighttime aerial reconnaissance photos during World War II, and MacRoberts never left.

I was going to start by saying that, in his work, Doc had two loves: flash lamps and sonar. But that wouldn't be fair, and would present an abridged view of the person Doc was. Really, he loved all things, and had a natural curiosity about the world around him and the people who drove it. He also had a disarming way of approaching people, even in technical disciplines. Case in point was this interaction with a graduate student he met in the hall:



Doc: What do you work with?
Student: I'm in materials science, and I work on superconductors.
Doc: Does that stuff really work?
Student: Yes, if the temperature's low enough.
Doc: I'd like to see that. You got any on you?

My first contact with Doc was his "Hello Peter" on the back of a postcard he gave me—one of thousands he dispensed as his calling card, this one a bullet through an apple. ("That's how we make applesauce at MIT.") It was my freshman year, and I was still wandering the halls with my neck stretched to look down intersecting corridors and up at the chiseled names of MIT's war dead. My father had worked in photography, and I knew that Doc was famous when I went to his annual lecture series during IAP. He was a tireless promoter of the things he was interested in, and his enthusiasm was infectious. But I was only a freshman and a single face among dozens in the room. I never imagined we might be colleagues some day.

I took Strobe Lab my junior year, and had an excuse to spend time around Doc in the lab. Of the hundreds of students Doc interacted with each year, I can't explain the chemistry that made us friends. Nevertheless, after working every summer since high school, I resolved that summer to apply myself to helping Doc. He was doing interesting things in lots of different disciplines, and needed help. Pouring water down stairwells and spending a good deal of time tooling around Boston Harbor testing sonars even-



tually led me to do my senior thesis with Doc.

We were working on the problem of turbulent flow in falling water drops: trying to predict at what point during their free-fall the drops would become unstable enough to break up. The same week that my thesis was due, Nebraska Public Television was scheduled to film Doc and the Strobe Lab. Both Doc and I got in early each day, a few hours before the film crew arrived, and Doc ran experiments for me while I wrote. We spent the rest of the day working with the crew, and then, after they left, Doc stayed with me into the evening, trying to get the thesis to department headquarters before the deadline.

Doc signed my thesis in January of 1983, but that just meant we were freer to follow our curiosity. At first, hanging around the lab was an excuse to avoid the "real" world; ostensibly, I was working on bringing my thesis up to publication quality. (Doc already had a journal lined up to consider it.) I was in no hurry to find a full-time job, and Doc encouraged me to explore all possible avenues before I "got serious." The day after he signed my thesis, he announced, "We've got to get you a job, son!" and got on the phone to EG&G, asking, "Have any vice-presidents retired this week?" (We had a running joke where he'd say, "I have great hopes for you, son!" and I'd reply, "Well, I'm glad I have *somebody* snowed.")

He was as much a father as a friend to me, a mentor *and* a pal, and he taught me as much about human nature as he did about science. Doc was a flesh-and-blood legend walking the halls of MIT. He had a smile and a "Hello" for everyone he met. I always liked to walk the halls with him

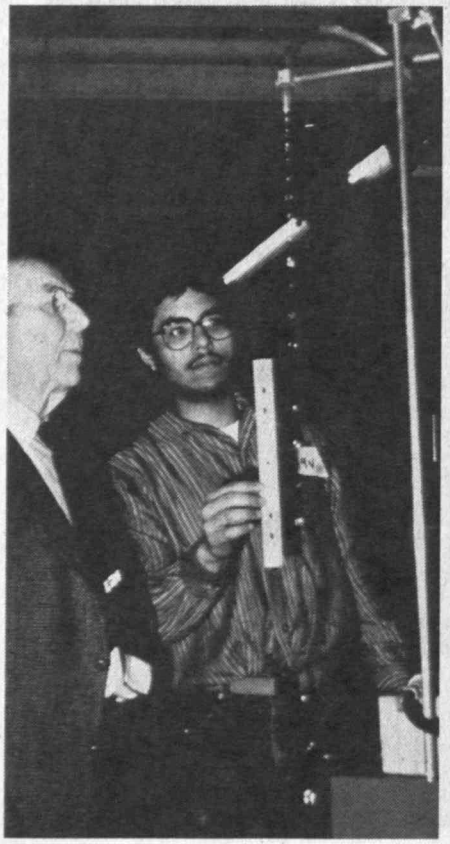


for two reasons: 1) I never knew who I might meet and be introduced to; and 2) more important, it reminded me of how easy it was to be friendly, how the fear of rejection could be enormously offset by the chance of a return greeting and a smile.





Doc's friendship and collaboration with the undersea explorer Jacques Cousteau (shown above on campus in 1973 and at right with the crew of Calypso *in 1955) led to many adventures in nautical archaeology. Various sonars invented by Doc enabled them to discover such sunken ships as the USS* Monitor, *the HMS* Britannic, *and Henry VIII's flagship, the* Mary Rose. *At lower right is one of Doc's cameras that had remained entangled on the* Monitor *for two years. Author Peter Mui accompanied Doc (waving from the* Calypso *helicopter, upper left) on Cousteau's trip to Matanzas Harbor in Cuba to search for the remains of a Spanish gold fleet ambushed by Dutch pirates. Mui (lower left) did his thesis with Doc on why raindrops aren't bigger.*



Sometimes, people didn't know what to make of him. As an elevator door would open onto a sea of unfamiliar faces inside, Doc would greet them collectively as he crowded in, as if they were old friends he saw every day.

I was continually surprised at how honored people were to be introduced to Doc. He treated everyone with the same small-town friendliness, for he never forgot his Nebraska roots. Doc had a rapport with people that was unmatched: everyone, from the president of the United States to the "lowliest" high school student, merited the same cheerful greeting.

It also amazed me how *everyone* at MIT knew Doc. All of the Campus Police officers, most of the Physical Plant staff. And the students? Why, Doc was one of the reasons you *came* to MIT. And when we went through the lock on the Charles River in a boat to do sonar work in Boston Harbor, the booming voice of a lock operator would descend from the loudspeakers in the control tower above, saying "How ya doin' today, Perfesser?"

Visitors to "Strobe Alley," the hallway through the Strobe Lab, could never be sure they weren't going to be accosted by Doc. Someone once told me that her parents were playing with one of the "stop-the-drop" exhibits in the hallway when Doc came up from behind and said unassumingly: "What have you got there?"

The parents, who initially had no idea who he was, started showing him the exhibit and describing how it worked. As recognition began to dawn on the mother, she asked who he was. "Why, I'm the king of this place!" he beamed.

There are five strobe lights blinking on the four-story courthouse in Aurora, Nebraska, Doc's home town. They are donations from Doc. One of the five



occasionally shows up in the lab for repair, packed rather haphazardly in a box from the local grocery store, with a multitude of cancelled stamps across the top. Repaired by Billy MacRoberts, Doc's technician of 47 years, the strobe goes back in its box for the return trip. Doc claimed that those five strobe lights are one of his most successful experiments: "Why, in 25 years," he was fond of saying, "not a single plane has crashed into that courthouse."

Sometimes I wondered what he really knew and what he was just feigning. When I would make a prototype of a new electronic device out of integrated circuits, Doc would look down at the black epoxy packages amid the rat's nest of wires and snort, "You don't really expect that bunch of cockaroaches to work, do you?"

But even as he got older, he was always looking for new angles into his work. The fluid crowns and splashes that he had made famous decades before became a resurrected subject for his latest variation: photographing them from below. I remember asking myself why I was still hanging around, and when I saw those photographs, I said to myself, "You know, he's still got it."

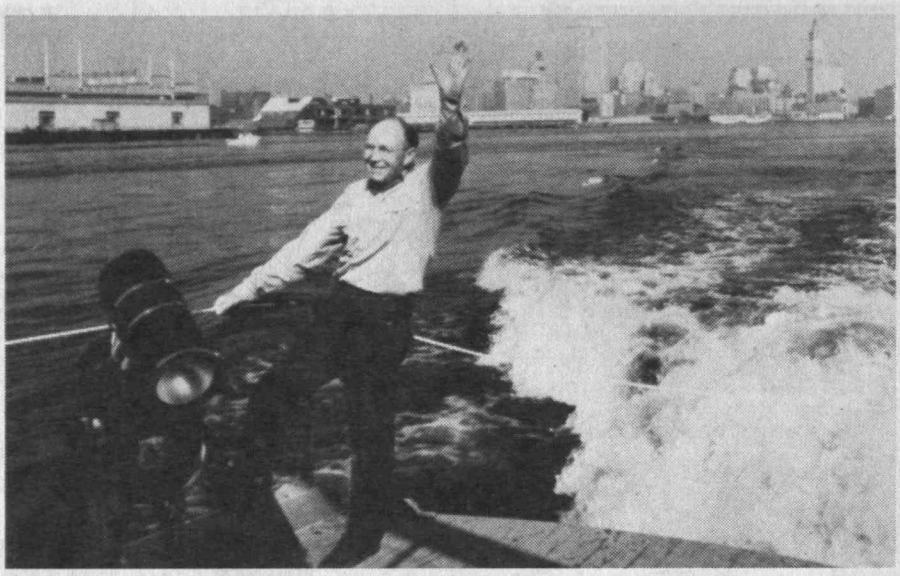
Doc had a real scientist's drive for detail, for tests that yielded more and better data. Once, we were checking an underwater camera we were contemplating sending to Loch Ness to search for the famed monster. We had gone out in Killian Court, where Doc paced off various distances while I snapped a series of pictures, each one farther away than the last. We were somewhat disappointed with the resolution we were obtaining: the images had a focal point but no crispness. Reflecting on the minute image of himself in the pictures, Doc said "I want to be able to read the time on my watch." He used to say the same thing when we went out into Boston Harbor to scan the Harbor Tunnels from above with assorted sonar devices: "I want to be able to read the license plates on the cars going through."

I was always pushing Doc to send me on one of the excursions to Inverness to search for the monster with sonar. "You want to go to Loch Ness?" Doc asked. "Sit on the edge of a Scottish lake, wearing a kilt, freezing to death? That's a job for a real scientist, not some impostor like you."

In 1986 we shared a cabin on Jacques Cousteau's *Calypso* off the coast of Cuba and it was obvious that Doc enjoyed being once again on board the ship where so many of his discoveries in nautical ar-



Boston Harbor was a favorite testing site for new sonar devices—if the tunnels under the harbor couldn't be located on the scan, Doc knew that the problem was with the equipment.



chaeology took place. He was a legend aboard *Calypso,* and his arrival was heralded both by crew members who had never met him and by Madame Cousteau, who had shared many of his adventures. On board, his nickname for decades had been "Papa Flash," and the crew quickly christened me "Baby Flash." My affiliation with Doc made me instantly welcome: hundreds of times, the goodwill he engendered previously opened doors and hearts to me whether he was present or not.

"Peter," Doc said once, "I'm thinking about all the wonderful things still hidden in the mud.

"First, we gotta find them.

"Then, we gotta clean 'em off.

"Put them in a museum.

"Figure out what they are.

"Publish some papers on 'em."

In the summer of 1987, Doc fell off a chair retrieving something from a high shelf in the lab. When he finally gave in and went to see a doctor two days later, it turned out he had broken two ribs. Complications from the fractures led to a heart attack and a hernia operation in short order. After that, Doc slowed down quite a bit, but he still came in to the lab as much as he could. At first, his wife Esther would drive him in and pick him up. But as he gained strength he was able to walk to and from his apartment at 100 Memorial Drive, just past the President's House, to Strobe Alley, almost directly beneath the Big Dome.

Once he was in, his energy wavered. Any given hour he was in the lab, he might spend half of it dozing off upright in a chair. Still, he wanted to be there, wanted to be part of the activity. What impressed me was his determination not to let old age beat him, his desire to stay active until the very end. He always wanted to know what was going on.

Doc spent some time in the MIT Infirmary last spring, having just been transferred from Mt. Auburn Hospital. Mrs. Edgerton had asked me to bring him his mail from the lab, so I was there as he was being admitted and the nurse was registering him. As she was taking his vital statistics, he was following her check-up procedures with his own commentary: "Blood pressure: OK . . . Pulse: OK . . . Heartbeat: OK . . . Appetite: Humongous!" She asked: "Do you have any allergies?" "Only to certain students," he chuckled. Even when he was ill, he never complained. He was always trying to keep everyone's spirits up.

I saw Doc often during his last two weeks. At Christmas dinner with him and Mrs. Edgerton, I mentioned that the fundraising I was doing for a project was going so well that I might actually have more money than I knew how to spend. "Hire some lawyers," quipped Doc, "they'll help you spend it."

A few days later, we attended a dinner together given by the Archaeological Institute of America. Doc had received the Pomerance Medal for Scientific Achievements in Archaeology earlier that day. "Good thing it's not gold," he said, stuffing the medal in his coat pocket rather haphazardly, "I'd have to worry about it if it was."

Then on January 4, Doc ate lunch at the Faculty Club with his lab technician and friend, Bill MacRoberts. They had spent the morning together and enjoyed their lunch. He paid his bill and was talking to the cashier about the new credit-card system the Faculty Club had introduced. She gave him his change, and he collapsed to the floor. According to his doctor, the end was swift and painless.

I think this is the way he would have wanted to go, and, other than Mrs. Edgerton, I can't think of a more fitting person to have been with him at the end. For four decades, Bill made sure that every piece of equipment Doc designed or used would work. He dotted the i's and crossed the t's in thousands of projects, and made sure that when Doc went out into the field, his gear would work perfectly. Bill knows how to repair things so that they'll work *better* after he fixes them. He deserved to be at Doc's side, and I can't help feeling that Doc planned it that way. He died with his boots on, and he died among friends.

Doc and I had joked, during this last year, that if we split the difference between our two ages, we would both be in our 50s and have a great time together. Surprisingly, I don't miss Doc as much as I thought I would. Maybe that's because I see him live on in all of the people he touched across the years. There's an enormous extended family of people whose lives were changed because of their interaction with him.

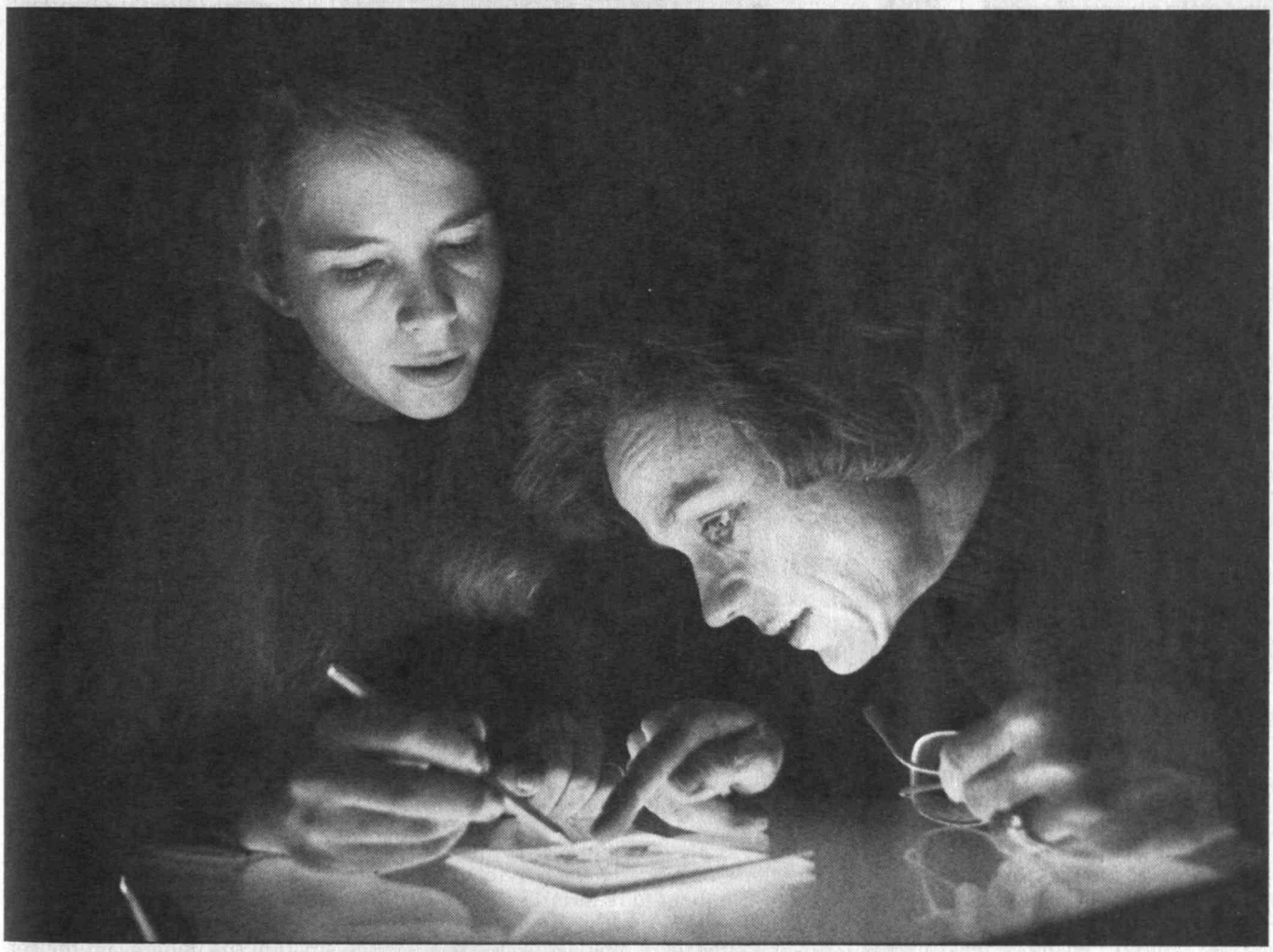
Doc was fond of saying "I have three lifetimes worth of things to do. I guess I'll have to leave some of these problems for the next generation." Only now, I realize that he meant it. He tried every day to look at the world with an inquisitive eye and to find out a little more about it.

"The trick to education," Doc said, "is to teach people in such a way that they don't realize they're learning until it's too late." Even though he's gone, Doc still teaches me every day.—*Peter Mui* □

The author is a research affiliate at the Strobe Lab and writes technical documentation. He is interested in forming a "Friends of Doc Club," and invites interested people to write him at 59 Bishop Allen Dr., Cambridge, MA 02139

BY TOM EHRENFELD

The Care and Feeding of Hybrid Health Research



Graduate student Alice Flaherty (left) examines slides of monkey brain tissue with her advisor, Prof. Ann Graybiel.

As Gramm-Rudman looms over the federal budget and the percentage of "approved grants" that the National Institutes of Health can afford to fund drops from 35 percent in 1988 to 24 percent this year, researchers are scrambling to find alternate sources of support. And if the financial climate is grim for scientists and experiments that are well established and respected, dollars are even harder to come by for graduate students and young faculty just beginning their careers, or for senior scientists who want to try novel experiments.

It's debatable whether "one thousand points of light" flourish nationwide, but at least one beacon burns at MIT, where the Whitaker Health Sciences Fund turned 15 last year. The Whitaker Fund supports MIT doctoral students and faculty, as well as some faculty from nearby institutions, who are hybridizing research in the fields of science and medicine.

"Our conviction is that a lot of advances come out of interdisciplinary studies," says Whitaker Fund President Irwin Sizer. Launched in 1974 by Uncas Whitaker, '23, the Health Sciences Fund (as it was originally titled) was created to support a specific class of research: that which applies science and engineering to the field of medicine.

The first beneficiaries of the fund were six doctoral research projects and seven faculty projects that shared a total of $245,000. In 1989-90, 20 students and 32 faculty received grants totaling more than $3 million.

And yet "there is never enough money for these people," says Sizer, the dean emeritus of the MIT Graduate School. He says this "elite program" helps students and faculty who are truly on the cutting edge of applied medical research.

The list of Whitaker grant recipients includes Nobel Laureates David Baltimore, '61, H. Gobind Khorana, and Sus-

PHOTOS: L. BARRY HETHERINGTON

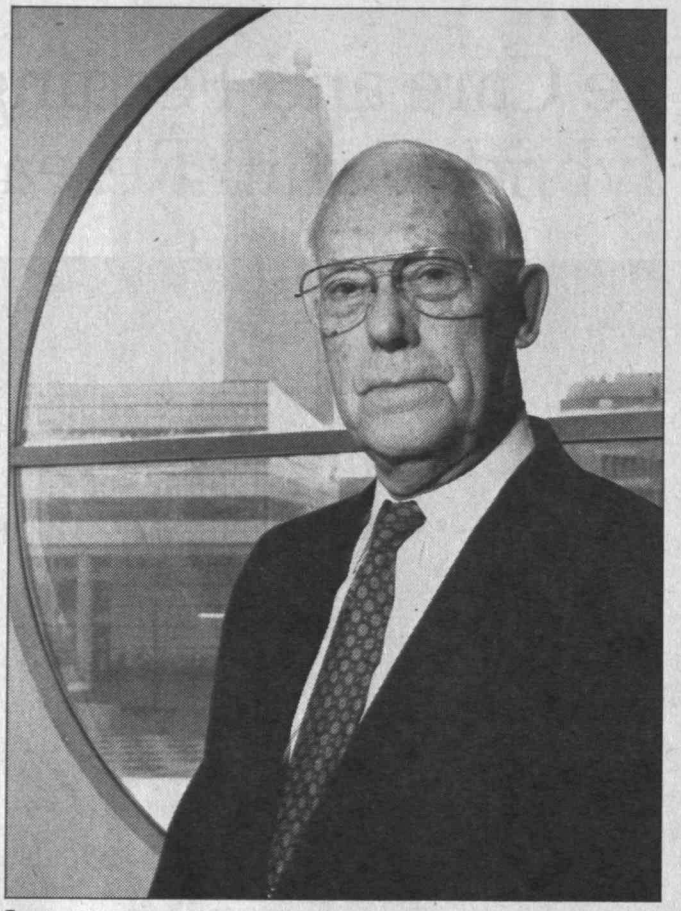
umu Tonegawa. But internationally recognized figures make up a small part of the program. For in its goal of supporting innovative work that might not find grants from larger bodies like the NIH or NSF, the fund seeks promising researchers early in their careers—the time when they most need support and recognition.

Participants say the greatest value of this fund is that it allows students and faculty to work in fields that generally do not attract support from traditional sources—work that biologist Frank Solomon characterizes as "risky."

Germeshausen Professor of Chemical and Biochemical Engineering Robert Langer, ScD '74, notes that "[The Whitaker Fund] is good at bringing people together. It's good at helping create interdisciplinary projects, and good for raising seed money for projects that you might not otherwise do."

As the fund has grown, so has the scope of its work. Students and faculty in the past have tackled such projects as tracking the metabolism of cholesterol, investigating the freezing of internal organs intended for transplant, and studying the nutritional requirements of premature infants.

The Whitaker mandate has always been to support research in the life sciences, medicine, bioengineering, and related fields, such as public policy, environmental pollution, and even medical statistics and economics. In recent years, according to fund publications, the support "has shifted somewhat from bioengineering to molecular and cellular biology."



Irwin Sizer, president of the Whitaker Health Sciences Fund.

Robert Langer has been the beneficiary of seven Whitaker grants to date. Widely recognized for his efforts in the field of drug delivery systems, he is now working on two collaborative projects with other faculty in the field of polymers. Polymers, he says, "affect every aspect of medicine." They are used in contact lenses and ocular lenses; in artificial hearts, lungs, kidneys, and joints; and in orthopedics.

Langer and Charles Vacanti of the Harvard Medical School are developing polymers as a temporary substrate to grow new cartilage in a joint. "The idea is to take biodegradable polymer scaffolds and seed cells onto them—in this case chondrocytes. . . . The hope is that we can use them to re-form cartilogical structures."

The scaffolds are intended to temporarily facilitate the growth of cartilage and then degrade when the work is done. Although in this instance the polymers act primarily as structural support, Langer says they could eventually be formed to include growth factors and immunosuppressants.

Additionally, Langer and Boston University Professor David Larson are engaged in a joint effort to develop a new family of polymers specifically suited to implantation in the human body. The polymers now used in medical applications are synthetics that were originally designed for other purposes. Polyether-polyurethanes used in artificial hearts, for instance, were originally used in girdles. The goal of Langer and Vacanti is a biodegradable polymer built from a natural substance.

Graduate student Alice Flaherty's Whitaker-funded research explores the not-yet-understood connection between two separate parts of the brain. Specifically, Flaherty is investigating the effect that nerve impulses in the brain's cortex have on gene expression in the neighboring striatum. This nerve firing, or electrical activity of the brain, may play a role in diseases that affect the striatum, such as Parkinson's and Huntington's.

Flaherty is working under Professor Ann M. Graybiel, PhD '71, (also Whitaker-supported) in the Department of Brain and Cognitive Sciences. She describes her project as a "study of how neural activity in sensorimotor areas of the cerebral cortex regulates expression of neurotransmitter genes in sub-cortical structures, such as the striatum."

The cortex contains representational maps of the body that control our ability to move and our sense of touch. Electrically stimulating one of these map sites causes a reaction in a specific body location, such as hand movement. "It may also change levels of gene expression in brain areas such as the striatum," Flaherty believes.

The striatum sits underneath the cortex, and nerve cells transmit impulses from the cortex to the striatum. The striatum, Flaherty explains, was once thought of as a "homogenous blob of tissue." But scientists have discovered that it has a complex internal architecture, and that architecture is very much involved both with the striatum's control of body movement and of neurotransmitter levels."

Neurodegenerative diseases such as Parkinson's and Huntington's are characterized by the loss or improper modulation of some striatal neurotransmitters, as well as by disorders of body movement. Working with the brains of primates, Flaherty is investigating how the modulation of cortical output affects the striatum. By

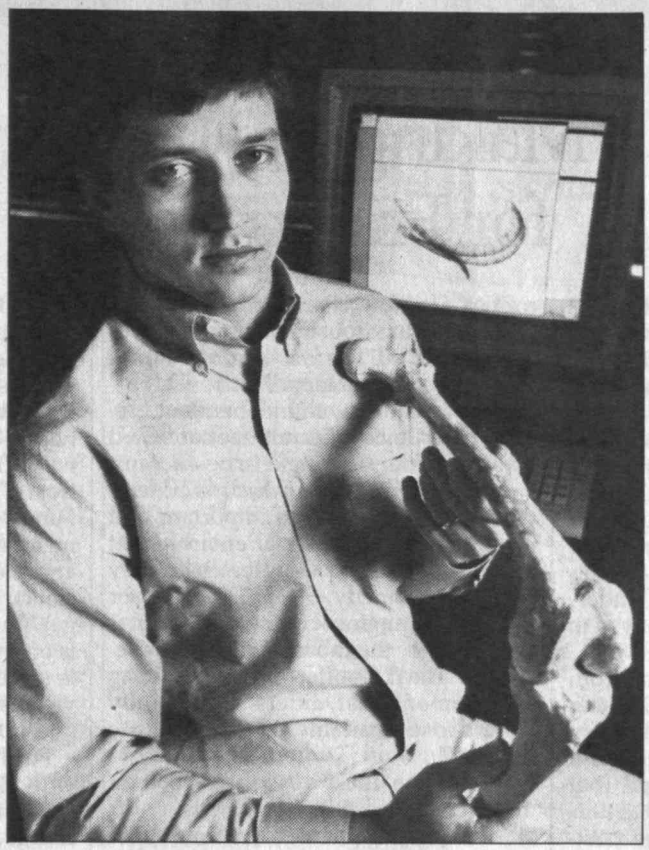
delving into the impact of cortical activity on the production of striatal neurotransmitters, Flaherty hopes to unlock some of the secrets of how to regulate more effectively these important brain chemicals.

"If we know what is going on, then, theoretically, we can devise techniques that deliver specific neurotransmitters only where they are needed in the striatum," she says. "Such techniques might help the hundreds of thousands of Americans who suffer from neurodegenerative diseases."

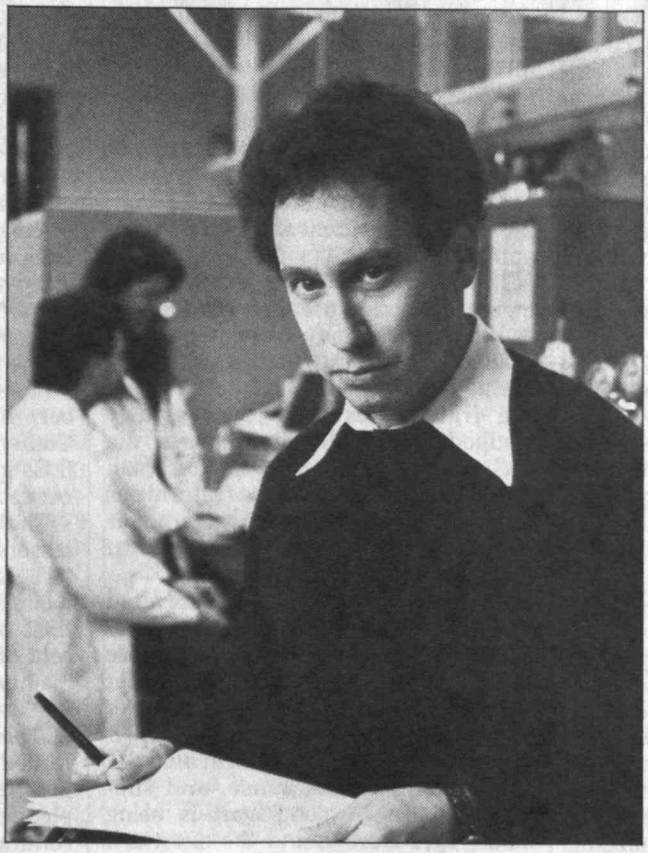
One of the sticking points in any defense of the existence of God surely is explaining how She could have allowed such a piece of poor design as the human knee. For a joint that looks so simple on the outside, it is appallingly vulnerable to some of the more complicated injuries. Why? "The knee is not a simple hinge joint," says Robert Fijan, SM '85, a doctoral candidate in the Department of Mechanical Engineering.

The knee is actually a busy intersection where the tibia articulates onto the femur (the body's largest bone) with the help of 15 separate muscles. "It rolls and it slides and it rotates," Fijan says of the tibia. And therein lies the challenge of his Whitaker-funded project, developing "a 3-D mathematical model of the human knee joint."

"I'm basically trying to understand how the human knee works—how the muscles control the knee and how they relate to the motion of the knee," says Fijan, who is finishing up his work this semester and plans to move on to a teaching post at the University of Michigan starting in May.



Robert Fijan's model elucidates the human knee.



Seven Whitaker grants have supported Robert Langer's work.

He explains that all human movement involves what appears to be unnecessary co-contraction or co-activation of muscles. Fijan says scientists know that co-activation of muscles is tied to the stability of the joint, but they don't have a good explanation of what happens and why.

"The problem with a human [joint] is that you can't really measure how things happen internally. So you are left with measuring external things and finding ways of inferring what the real results are."

Kinematic research is conducted on cadaver knees, on the assumption that the joint moves the same way in a living person. But that assumption ignores the role of muscles, producing a seriously deficient model of knee action.

Fijan, too, takes data from cadaver knees. But he goes on to construct a complex, three-dimensional model on the computer, one that includes such factors as the geometry of the knee, equilibrium analysis, stability constraints, and muscle analysis. "I'm trying to see how well my predictions of co-activation due to the requirements of stability correlate with, say, the amount of rolling and sliding," he says.

The countless Americans who suffer with knee problems and football players everywhere, to say nothing of the physicians who treat them, surely hope Fijan's contribution to understanding the knee translates into better strategies for care. □

TOM EHRENFELD is a freelance writer and a member of the editorial staff at the Harvard Business Review.

Making the Case for Fraternities

For most of their history, MIT's 33 fraternities and other independent living groups (collectively, the ILGs) have been under threat by rough seas from one storm or another—shifting real-estate values, changing MIT demographics, evolving social mores. But for more than a century the ILGs have proved resilient to the buffeting. They continue to be supported by the Institute and cherished by their residents—a significant proportion of all MIT undergraduates—as important alternatives to dormitory living.

The newest challenge has come from inside: an ad hoc Freshmen Housing Committee, chaired by Professor Mary C. Potter of the Department of Brain and Cognitive Sciences, has proposed that all first-year students be assigned to dormitories and that Rush Week be postponed until the end of the academic year. The recommendations are under consideration by the Provost's Office. Students, of course, object to any policy that reduces their arena of choice, but the threat to the ILGs is more than a matter of principle. Even if interest in nondormitory living stayed about the same, the recommended change would mean that about 25 percent fewer students would live in the ILGs. Many of the houses could not survive economically at three-quarters capacity.

The strength of the support enjoyed by the ILGs can be measured by the intensity of the reaction to the recommendation for a delayed rush. Students, alumni/ae, and faculty have joined the debate. However the issue is resolved, it will have provoked many members of the community to take a serious look at the housing options for MIT students.

This Time, the Students and the Dean See Eye to Eye

As I concluded an interview for this article, I told Shirley McBay, dean for student affairs, that she seemed very supportive of MIT ILGs. "Absolutely," she replied. Indeed, she said, a major goal is to find housing for sororities so that MIT can offer to undergraduate women the same broad range of housing options that it offers to men. (Four sororities are now chartered at MIT, but none as yet has housing—though it's rumored that MIT's first sorority house may very soon be identified.)

Only a year ago, an Independent Living Group Review Committee convened by McBay found a single issue—acceptance of minorities—on which to criticize the ILGs. They are "an important and positive part of the social environment at MIT," said the committee chaired by Robert S. Kennedy, ScD '63, a professor of electrical engineeering and computer science and the housemaster at MacGregor. The ILGs offer "a valuable living environment that differs significantly from those available in the Institute houses."

Consider the ILGs' responses to their major challenges since the 1950s:

- With management help from their alumni, ILGs survived the era of double-digit inflation so successfully that they are on average the lowest-cost option for undergraduate room and full board at MIT.
- Many off-campus ILGs have achieved significant community acceptance in their increasingly upscale neighborhoods.
- With important financial help from the MIT Independent Residence Development Fund and some Institute investment, the ILGs now accommodate more undergraduates than ever before.
- While undergraduate demographics changed dramatically in the 1980s with the admission of many more women, the fraternities have successfully pledged ever-larger proportions of the declining male fraction of the freshman class. And three former fraternities parted with their national brotherhoods to become successful, independent, coed houses.

As the 1990s begin, the ILGs are faced with the toughest task of all, says Neal Dorow, the member of the Dean's Office staff who advises fraternities and other ILGs. It's not the challenge of the Potter Committee but of today's social imperatives: to deal responsibly with minority recruitment, sexual abuse, and substance abuse. A good start is being made, says Dorow, and the effort is a powerfully maturing experience for living-group members. If they don't continue to make headway on these issues, he believes, they will fold.

In its first issue last fall on the eve of Rush Week, *The Thistle*, MIT's "alternative" student newspaper, warned the new Class of 1993 against the fraternities. They are elitist, wrote Archon Fung, '90, and Penn Loh, '90: "The members think highly of themselves, and they choose people to join who are similar to them. Those who don't 'fit in' get 'flushed' from the system." Rushing is often pressured, the selection process is secret, and freshmen are likely to be victims of intimidation, charged Fung and Loh.

Furthermore, fraternities are inherently sexist, wrote Caroline Jean Lee, '91, in the same issue of *The Thistle*. She charged residents with sexual stereotyping and harrassment, and alleged that "date rape" occurs at fraternity social events.

But *The Thistle*'s big headlines and inflammatory stories had little apparent effect on Rush Week. Some two-thirds of the freshmen surveyed by *The Tech*'s Linda d'Angelo, '90, had read the articles (and they did so at one of the most impressionable moments in their MIT careers). Most readers called the articles "helpful," but few if any seemed motivated to abandon Rush. By the end of the week the ILGs had pledged more than 360 freshmen, essentially the same as the year before.

"Rush went well," Anthony N. Gerber, '90, president of the Interfraternity Conference (IFC), told *The Tech*. "Most ILGs got the number of freshmen they needed to fill their houses."

That result is significant for three reasons:

- Because of the growing number of women admitted to MIT, the all-male ILGs needed to pledge close to 50 percent of the men in the Class of 1993 to maintain their numbers—an intimidating "capture rate," in IFC jargon.
- This year's new pledge classes included more underrepresented minorities than ever before—12.5 percent of all pledges, according to Dorow. The ILGs continue to grow in diversity, he says.
- Last fall, for the first time, the use of

Alumni/ae support for Independent Living Groups is critical to their survival.

alcohol during Rush Week was regulated under rules written by the IFC in 1988-89. At every party where alcohol was available, living groups had to have at least four members present who had attended an Institute-sponsored alcohol-management program. Alcohol could be served only to students wearing wrist bands identifying them as 21 or over. Maureen Fahey, '90, told *The Tech* that the IFC's Judicial Committee, which she chairs, made spot checks throughout Rush Week; the policy worked "fantastically," she said.

McBay and some alumni who have key roles in the ILGs are not quite so sanguine. McBay said that she'd "like to walk in and not see bars as the focus of the common space in so many living groups." And alumni report finding enough evidence of drug use (if not abuse) to cause concern. But they understand and support MIT's long-standing policy of expecting ILGs to be the primary managers of their own affairs and arbiters of their own standards.

Alumni of the ILGs are essential to their success. Indeed, it's generally felt that without alumni support the fraternity system would have failed long since.

All the fraternity houses, and many other ILGs, are owned by nonprofit corporations of which alumni are the officers. Nearly every one of these is visited regularly—typically once a month—by the officers of its alumni corporation. Alumni and students work together on management issues such as budgets, policy, personnel, and maintenance. While contributing their expertise, says McBay, the alumni also give residents a lot of valuable guidance in how to run what are, in effect, small businesses.

A significant result of this self-management is that fraternity house bills for room and board can be under $3,000, while the cost of a room alone in the dormitories ranges from over $2,200 to $2,800.

Such modest house bills cover current expenses only. Most MIT ILGs are undercapitalized. They can afford to be because alumni have given substantial support to an MIT Independent Residence Development Fund (IRDF) whose purpose is to make low-interest (3 percent), long-term (up to 40 years) loans to ILGs for capital improvements. Since it was founded more than 25 years ago, IRDF has loaned more than $5.5 million to ILGs, and it now has between $1.5 and $2 million in available funds.

That "nest egg" is about what it should be, says Lindsay Russell, '50, who chairs the IRDF Allocation Board. A sudden opportunity—to help buy a sorority house, for example—could cause that $2 million to "go whoosh down to nothing," says Russell.

Dorow's enthusiasm for IRDF is boundless: "We wouldn't be where we are today without it," he contends.

From among their officers, the fraternity corporations select representatives to the Alumni Interfraternity Conference, which in turn meets four times a year with the Dean's Office staff to discuss ILG issues and policies. For Stephen C. Stuntz 3rd, '67, a past president of the Sigma Phi Epsilon alumni corporation, being president of the Alumni IFC is "the alternate reality" to his job in the top management of Acorn Structures in Concord, Mass. Stuntz is at the SPE house at least once a month, chairs the four meetings per year of the Alumni IFC, talks often with the Dean's Office, meets regularly as a member of the IRDF Allocation Committee, was for two years a member of the Kennedy Committee appointed by McBay in 1986, and was a consultant to the Potter Committee.

For another measure of alumni loyalty, consider the celebration last June of the centennial of the MIT chapter of Delta Tau Delta. More than one-third of all the house's living alumni—some 350 ILG enthusiasts—returned to the campus for two days of social events.

But there's a seamier side to the ILGs' alumni relations. Gerber said that some ILGs are owed as much as $20,000 in past-due house bills by their recent graduates. He's encouraged that many ILGs are now aggressively trying to collect—and that MIT is trying to help.

MIT ILGs have escaped much of the "animal house" stigma that is associated with fraternities on some campuses. McBay reports with noticeable pride that, over time, there has been no significant difference in academic performance between the residents of ILGs and Institute houses. And Dorow, who was the fraternity advisor at the University of Oregon and is acquainted with chapters across the country, says that fraternity management is typically much more responsible at MIT than elsewhere. "I'd find it difficult to be the fraternity advisor at another school after being at MIT," he says.

Relations with the communities in which their houses are located have not been without problems, however. Community service activities were emphasized in the 1950s as a tool for patching up neighborhood relations tarnished by noisy streets and exuberant parties. Now, McBay thinks, the commitment is deeper—a recognition by the ILGs that they must share long-term social responsibilities. Two examples: last fall more than 100 freshman pledges worked for a full day on community projects in Boston, Cambridge, and East Boston; and early in the winter, Phi Delta Theta produced hundreds of toys in the MIT Hobby Shop for Christmas distribution to hospitalized children.

As mentioned by many observers, the fraternities' record in minority pledging has been abysmal. Figures assembled for the Kennedy Committee in 1987 showed that Asian-Americans and the underrepresented minorities—African-Americans, Native Americans, and Latinos—were less than 15 per cent of fraternity pledge classes between 1983 and 1987. But in the same period, these groups were 25 to 35 per cent of freshman men.

The committee sharply criticized this record, but noted that minority pledging to ILGs increased significantly during the five years covered by the committee's data. And last fall, when the fraternities pledged 47.5 per cent of nonminority men in the Class of 1993, they also pledged 38 percent of the African-Americans—a higher proportion than ever before. At least at present, the trend is in the right direction.—*John Mattill* □



CLASS NOTES

15 75th Reunion

Please send news for this column to: **Joyce Brado,** acting secretary, 491 Davison Rd., #9, Lockport, NY 14094

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We regret to report the passing in late 1989 of three of our classmates: **Miguel Marquez** of Chihuahua, Mexico; **Roy Sidelinger** of Sun City, Ariz.; and **George Ousler** of North Andover, Mass. Miguel lived all of his life in Chihuahua. Roy was a retired executive of Jordan Marsh Co. and a little over a year ago moved to Sun City, Ariz., from Dover, N.H. George was an electrical engineer with Duquesne Light Co. in Pittsburgh, Pa., and from 1942-1960 he was the executive vice-president of that company. Following his retirement in 1960, he was a management consultant for Emerson Electric Co. and Potomac Light and Power Co. in Washington, D.C., from 1960 to 1966. George's son reported that his father "helped raise millions of dollars in the Pittsburgh area for MIT, and it was not unusual for the Institute's president to be at the house for dinner." Also, his son noted that "after World War II, he and several colleagues were called on to give advice on how to implement the Marshall Plan and rebuild Germany." His son, George W. Ousler, Jr., MD, an orthopedic surgeon in the North Andover, Mass., area, also stated that his father worked with several other leaders of top companies in Pittsburgh to vitalize downtown Pittsburgh into the Golden Triangle. "In that project, he was known for his unique ability to bring people together over a difference of opinion and resolve it." We had the pleasure of knowing George and his wife Claire, who survives him, on those occasions when they joined us at class reunions. May these and all of our deceased classmates rest in peace.

We had this letter from **George Crowell**'s son Bruce about his father: "He has been at West Acres Nursing Home in Brockton, Mass., since March 1989 after a month in the hospital following a fall at home when he broke his wrist and injured his back. He suffers from a lot of arthritis but is now up and walking around with the aid of a walker and cane. His spirits are good and his mind is as sharp as ever. His eyesight has been impaired for several years, but he recently had a cataract operation and is being examined for new glasses that we hope will be beneficial. His interest in current affairs, the stock market, the Red Sox, and *Jeopardy* is as keen as someone half his age. He will be 96 next January 29 (1990). We are looking forward to having him with us on Thanksgiving at a family gathering that will include his two great-grandchildren." Thanks, Bruce. We're pleased that George is doing so well. We're counting on him to be with us for our 75th reunion.

Dina Coleman added to our joy at Christmas with his special greetings. . . . Again, write when you can. Let us know if we can be of any assistance.—**Bob O'Brien,** acting secretary, 25 Keith Rd., Pocasset, MA 02559

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I regret to report that **Harrison P. "Bill" Eddy, Jr.** died November 7 of pneumonia in Beverly, Mass., hospital at the age of 94. A graduate of civil and sanitary engineering, he took over the firm of Metcalf and Eddy of which his father had been one of the two founders. He became a partner in 1926, president in 1959, chairman in 1970, and retired a year later.

In its early years, the firm specialized in treating wastewater that mills discharged into New England rivers. Bill helped the company expand into a worldwide operation with expertise in military as well as water supply, wastewater treatment, and incinerator projects. During his 52 year tenure, the firm carried out projects in Calcutta and Rangoon, India, Manila, Vietnam, Egypt, Spain, Iran, and Antarctica.

Under his leadership, the firm in the 1950s designed the air force base in Thule, Greenland, and the Early Warning System radar stations in Greenland and Alaska.

He served as president of the American Society of Municipal Engineers and the Boston Society of Civil Engineers and was a registered professional engineer in 16 states and Nova Scotia. His wife, Elinor, survives him.

Once again, let me add I would like to hear from you of 1917 so by these notes I can pass on your comments to your classmates and to other friends who do, indeed, read these notes as well as those of their own classes.—**Don Severance,** acting secretary, 39 Hampshire Rd., Wellesley Hills, MA 02181

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In early December, I mailed season's greetings cards to the 27 of us who are the saving remnants of the over 600 who first banded together at MIT in September 1914. I am very happy to report, as of January 1, 1990, to have received cards or letters from a number of you, for which I am very grateful. Holiday greetings came from Lorraine and **Stuart Caldwell, Art Williams, Henry Lacey, Herb Larner, Ben Greely, George Halfacre,** and **Charlie Tavener.**

From **Bill Collins:** "What can you expect for news from a 94-year-old cripple? The only excitement this year was a hospital stay with pneumonia. Hospital service is not what it was six years ago when I was laid out with Guillain-Barre Syndrome. The last hospital stay threw me back six years. Fortunately, my arms still retain their strength. Now to get the legs in line."

I am grateful to **Eaton Clogher** for a newsy letter concerning his struggle—the one we all have—physically coping with old age. He requested silence concerning his report, but I know he will forgive me for a few quotes. Isn't it great what our progeny are doing? He writes, "My three children, eight grandchildren, and one great-grandson keep me interested. They travel worldwide, use planes as we did the trolley cars. When I got out of the air service in 1918, I never wanted to ride in the damn things and never did. I rode; I was not as pilot. I miss my wife, a magnificent lady who passed away in 1945. I attribute the success of my two daughters and one daughter-in-law to her. The only time she ever got upset was when the younger girl decided to go to MIT and study architecture. Today I understand she is among the leading 100 women in that profession. The older girl, a lawyer, is considered to be a leading authority in her field. She is a professor at the law school of George Washington University. The boy is a master mechanic. He has three daughters and a son, the eldest working for a doctorate in nuclear physics at Stanford. The older daughter has a boy ready to go (we hope) to law school and a girl in the third year at Trinity. The younger daughter has a girl in high school who wants to become a research medical doctor and a boy who thinks he would like to follow his mother's trade and go to MIT."

A most welcome note comes from **Eli Berman:** "Your welcome letter found me and Christina on the island of Coronado off the southern coast of Florida. This is the location of a big naval base, although the only naval personnel that I could identify was a good-looking feminine petty officer in a smart blue uniform. The weather is delightful—sunny, 65 degrees. Out of the back door of my building a walk stretches along the beach as far as the Hotel del Coronado. People sun themselves on the sand, and walkers stroll along in scanty clothes and sneakers. The older son of my son Ralph, MIT '46, is engaged to marry a lovely girl from Montreal, Canada. I now have five great-grandchildren with another one on the way. We plan to be home in early April, after which we shall patiently await the good golf weather."

From the Alumni Association office, we received word of the death of **Myron W. Adams** in Falmouth, Mass., last October. He studied electrical engineering at MIT, business administration at Harvard, and attended Hamilton College in Clinton, N.Y. Adams was a former employee of the Bemis Co. in Boston and worked for a time in India. We express sympathy from our class to his family.—**Max Seltzer,** secretary, 865 Central Ave., Needham, MA 02192

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Please send news for this column to: **W.O. Langille,** secretary, P.O. Box 144, Gladstone, NJ 07934, (201) 234-0690

20 70th Reunion

Please send news for this column to: **Harold Bugbee,** secretary, apt. 313, Country Club Heights, 3 Rehabilitation Way, Woburn, MA 01801

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As these notes are being written, Christmas has come and gone and New Year's is approaching.

Christmas cards were received from Dorothy **Wenick,** Ruth and **Irving Jakobson,** Betty **Patton,** Celia **Huggins,** Helga **Parsons,** Claudia **Crosby, Leo Pelkus,** and Emma **Lloyd.**

Emma Lloyd writes that during the year she traveled to Denmark and Switzerland and at Easter went to Atlanta and Charlotte, N.C. . . . Claudia Crosby was spending Christmas in Washington, D.C., with her sister Marion. She is having trouble with her eyes but can still drive. . . . Helga Parsons has bought a condominium in Naples, Fla., and is spending the winter there. . . . Dorothy Wenick is keeping busy knitting for underprivileged children. She recently took a cruise in the Caribbean. . . . Celia Huggins keeps busy at Shell Point Village, Fort Myers, Fla., with extensive gardening and conservation. . . . Betty Patton has been doing volunteer work at a nursing home and also at an adult care center. She spent four days on Cape Cod at Thanksgiving.

I phoned **Cac Clarke** recently and learned that in collaboration with another resident he had written a book on his hometown Brielle, N.J. Cac asked me to urge more classmates to attend Technology Day in June and also think about a possible 70th reunion in 1991.

Helen **St. Laurent** reports spending the summer in Center Lovell, Maine, and seeing **Al Genaske.** Helen walks with a cane these days.

There are three deaths to report this month: **Harrol W. Baker** of Lakewood, Ohio, on August 19, 1989; **Edward M. Richardson** in Cambridge, Md., on September 11, 1989, and Major General **Franklin Carroll,** Littleton, Colo., on September 13, 1989.

Baker was a research chemist who developed a baby formula, a milk product for infant feeding. He earned a master's degree at Oberlin College and another master's degree at MIT. . . . Richardson served in World Wars I and II and was commissioned a major in the Corps of Engineers in World War II. . . .General Carroll's service goes back to 1914 where he served with "Black Jack" Pershing in the search for Pancho Villa in Mexico. He was designated chief engineer of the U.S. Army Air Forces in 1942.—**Sumner Hayward,** secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden,** assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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Karl E. Schoenherr, Course 13, and, I believe, our oldest living classmate, has recently written a most interesting short book (52 pages, $10.95) entitled *Coming to the United States—the Hard Way,* published by Vantage Press, Inc. He tells in first-person detail the story of his escape from a French prisoner-of-war camp in Tours on July 19, 1915, his travel on foot to St. Nazaire, stowing away on a ship bound for Montreal, jumping overboard as the ship passed Quebec, reaching Levis on the south shore, and then in 16 days successfully making his way to the German Consulate in Boston. Schoenherr, then at age 22 and a trained seaman, immediately found work in New York on a German ship, the *S.S. Ockenfels,* until April 1916 when we entered the war. Thereafter, as a registered alien, he served on a number of American ships in the coastwise trade, all the while improving his English and readying himself to enter MIT, which he did immediately after the war ended in November 1918. He was a member of the 1920 gym team, performing on the horizontal bar. During his junior and senior years, he was Frank Kanaly's assistant athletic instructor. The book jacket says, "This is an exciting tale that will be enjoyed by all with a yen for a good adventure."

A note from **Lee Carroll** tells of a grandson who graduated from Sloan School last June. News of the death of **Horace "Mac" McCurdy** last November 13 has been noted in previous issues. He was a giant in his field and will always be remembered at MIT particularly by those participating in crew. . . . Friends of the **Frank Kurtz**'s will be saddened to learn that Carlys died last July of cancer. Frank, while now confined to his chair, remains well and alert and still playing bridge. **Mac Dudley Perkins,** a retired structural engineer, died at age 92 on October 7, 1989, in Berkeley, Calif., after a short bout with cancer. He came to Tech as a sophomore after preparing at Colorado College. He had a long and successful career in California with offices in San Francisco and Monterey. He is survived by his son, David H. Perkins, of Chevy Chase, Md., two grandchildren, and four great-grandchildren. . . . **Dwight VandeVate,** Course X, a long retired management consultant, died September 25, 1989, in Rochester, N.Y. He is survived by his wife, Helen. . . . **Howard Davenport,** Course IV, died January 16, 1989, at Ghent, N.Y. No information as to his career or family has reached me. Our condolences are extended to the families of these deceased classmates.—**Yardley Chittick,** secretary, Box 390, Ossipee, NH 03864

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By the time these notes find their way into the *Review,* our mini-reunion will be over. At this time, your secretary has only had one definite return for attendance, that of **George Rowan** of West Hartford. Letters from **Cecil Green, Harry Halker,** and **Sherwood Berger** express regrets. However, it is still rather early for commitments. It can only be hoped that a good time will be had by all.

A letter during the summer from **A. Pyle,** Wilmington, Dela., states that on July 1, 1989, he flew to San Diego, Calif., to visit relatives. While there, he visited **Tom Rounds,** 4401 Moorbark Way, Toluca Lake, CA 91602, former secretary/treasurer. Tom has just returned from the hospital following an operation. Marjorie, Tom's wife, had returned from the hospital after treatment for a heart condition. Al comments that his hobby is building a model locomotive that runs by live steam on a one-and-one-quarter inch track. He says that he is enjoying his retirement.

As a member of the AWWA, New England Section, your secretary noted in the December 1989 *New England Water Works Association Journal* that **Horatio "Bondi" Bond** had been awarded, at the annual convention, "Gold Water Drops" as a loyal member of 50 years in the organization.

Howard Lockhart, 180 Water St., Apt. 402, Haverhill, MA 01830, has returned from a week-and-a-half-stay in the hospital and comments that his writing hand has not quite returned to normal. He retired in June 1966 from the Haverhill Gas Light Co. as general superintendent. He has traveled extensively. His activities have been and are many, including church, gardening, and traveling. Glad to hear from you, Howard.

The Christmas mail spawned the annual review of the year's doings in the **Dave Joy** family. Sorry to hear that Muriel had injured the other knee from the one that kept them from attending our 65th.

Our president, **Royal Sterling,** has become restless and has gone into business. He retired in 1972 and should be sufficiently rested to tackle the world again. If anyone yearns for a cocktail table especially equipped with an hourglass, he has them. Go for it, Royal.

Your secretary is sorry to report the death of **Russell W. Conant** on October 18, 1989. He majored in physics and received a master's in 1929. While at the Institute, he was active in the Chemical Society, the Civil Engineering Society, and the Math Club, and was also on the *Technique* Junior Board and the golf team. He married Marion Dibble of Holyoke, Mass., and had two children and four grandchildren. Following five years as an instructor in MIT, he joined Technicolor Picture Corp., Hollywood, Calif., where he worked for 37 years. He was a member of Lions International and was interested in photography, gardening, and travel.

It was reported that **Arthur Warner Germer** died on June 11, 1989. He prepared at Syracuse with a BS degree in 1921 and receiving a BS in mechanical engineering at the Institute. He married Helen Hynes of LaPorte, Ind. They had one son and four grandchildren. After graduation, he worked for the American Locomotive Co. in Schenectady and later for the Montreal Locomotive Works. He became president of the Engineers of Eastern New York. His interests were in tennis, golf, skiing, bowling, oil painting, carpentry, and organ playing.—**Frederick O.A. Almquist,** secretary, 63 Wells Farm Dr., Wethersfield, CT 06109

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I was very happy to receive information from several of the classmates. Thank you. **Chris Conway** reports that he still pursues his hobbies of gardening, church work, and performing arts. He is also very proud of his four grandchildren; Chris, an engineer; Blake, who works with a nationwide computer software company; Celeste, an account executive with an advertising agency; and Eileen, who teaches high school.

I received a copy of a newsy letter from **Phil Blanchard** to **Col. Stern.** Since graduation, Phil spent most of his professional career at Superheater Co. in New York City. He began there as a test engineer in 1950 and fondly recalls the thousands of miles he logged on steam locomotives as a troubleshooter. He culminated his tenure there as a senior vice-president, retiring in 1983. He and his wife, Besse (Burris), now reside in a lakeside community in Altoona, Fla.

George Knight writes that he and his wife have been living for the past 17 years half their time in England and the other half in New Hampshire. As soon as their New England home is sold, they plan to settle down full time in "old" England at 117 Spring Lane, Bisholtoke, Eartleigh, Hants, England S05 6AZ.

I also heard from **Adalberta "Al" Roig,** who had a pleasant time visiting with **Domingo Bellingeri** and his relatives from Argentina at the 65th reunion.

I regret to report the deaths of four classmates. **Allen W. Hawkins** died on September 20, 1989, in Livingston, N.J., after a long illness. Mrs. Lois Hawkins is interested in selling some of Allen's prize camera possessions (16mm sound recorder, sound camera, and sound projector) to a fellow graduate who will really appreciate them. She can be contacted at 12 Devon Dr., W. Orange, NJ 07052.

Alfred Gargaro died November 14, 1989, at Framingham Union Hospital. Alfred was born in Italy and came to the United States with his family at age 6 to settle in Quincy, Mass. After graduating from MIT, he worked as a civil engineer and land surveyor for the city of Newton from 1963 until he retired in 1972. After retiring, he operated his own business, Dale Engineering, from 1972 to 1977. He was a member of the Friends of Callahan in Framingham and the Eastern Massachusetts Association of Professional Engineers and Land Surveyors, Inc. He was a member of the Jamaica Plain Council of the Knights of Columbus and a former president of the Holy Name Society of St. Thomas Aquinas Church in Jamaica Plain. Alfred is survived by two daughters, Mrs. Delores Wilson of Framingham and Mrs. Elena Laffey of Houston, Tex., two sisters, seven grandchildren and one great-granddaughter.

Clarence "Dinty" Moore died on September 13, 1989, at Pine Manor Nursing Home in Columbus, Ga. Clarence was employed as a solicitor of the Patent Office, retiring in 1965. By attending night classes at George Washington University, he received a law degree and was also awarded an

Exceptional Service Award from the Department of Commerce in 1957. Clarence had a special interest in horticulture and was a member of the Potomic Rose Society, the American Rose Society, and the Takoma Horticulture Club. He is survived by his two children, Steven Moore of Winchester, Mass., and Arline Moore of Columbus, seven grandchildren, and four great-grandchildren.

Charles Ford died on October 2, 1989, in Middle Village, N.Y., after a long illness. He graduated from MIT with a chemical engineering degree and had worked for the federal government's Patent Office in Washington and the John Mansville Co. in New Jersey. Charles retired from the Department of Labor in New York City in 1969. He is survived by his wife, Edna Ford, his son, Richard, two sisters, and three grandchildren.—secretaries: **Katty Hereford,** Hacienda Carmel, No. 237, Box 5397, Carmel, CA 93921; **I. Henry Stern,** 2840 S. Ocean #514, Palm Beach, FL 33480, (407) 585-7682

25 65th Reunion

The holiday season brought greetings from several classmates. Elinor and **Sam Spiker** were at their winter home in Brookline, where they avoid some of the snow of New Hampshire, but cold temperatures of December 1989 have provided fine competition for that more northern state. . . . Adele and **Ed Kussmaul** look for warmer climate at their home in Briny Breezes, Boynton Beach in Florida. . . . From the West Coast, **Lillian Drew** indicates she will be coming East next summer but not until after the 65th reunion. . . . **Maxon King** and Esther wrote from Santa Cruz, Calif. Max said nothing about the October 1989 earthquake, which treated his town badly. He regrets he will not make the reunion and extends his regards to all classmates.

Charlotte Blonsky, who lives in San Jose, did report on the earthquake. In her words, "It pitched me on the floor, opened the refrigerator, and created a mess on the kitchen floor by mixing apple sauce, flour, strawberry jam, and lots of broken glass and china. Not a room or closet was spared." However, on the next day, when power was restored and TV news was available, the reports from San Francisco, Los Gatos, and Santa Cruz convinced Charlotte that her problems were small compared to those of thousands of others.

Professor **Y.H. Ku** reports that he and his wife visited the People's Republic of China for a month last fall. They were the guests of China's general secretary. While there, he gave three lectures on CHAOS at the universities in Shenyang, Hanchow, and Shanghai.

A letter from Mary Lou K. Stevenson, daughter of **George Kohfeld,** informs us that George died in Dallas, Tex., last December 6, after a short illness. For a number of years, he had been self-employed, advising on management and investments. He never retired, although in his latter years he admitted being semi-retired. George is survived by two daughters and six grandchildren.

Belatedly, the passing of **Oscar Ramis** has reached alumni headquarters. Oscar died on June 9, 1987. He had come to the Institute from his home in Uruguay and after graduation returned there. To the best of our knowledge he worked in that country throughout his career and passed away in his home city of Montevideo.—**F. Leroy "Doc" Foster,** secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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I received a Christmas Card from **Shia Yong Shih** from Beijing, China, and his wife, including an excellent picture of the two of them on a rock with the Great Wall and a hill with two beautiful buildings in the background. We have been exchanging Christmas cards since we met in 1983 when we were in China with an MIT group. He is still teaching at Tsing Hua University. . . . A letter from **John H. Wills** from Colorado Springs, Colo., wrote mentioning an unforgettable MIT experience at a black tie dinner for MIT Sustaining Fellows (those who make lifetime gifts to MIT). He was disappointed not seeing any '26 classmates at the dinner. One of the ways to make lifetime gifts is to the Compton Fund, which I described in the January 1990 issue. . . . **Lester G. Hopton** of Boca Raton Hotel Club in Florida, died September 4, 1989. He was the former president of the Ingersol-Rand Co., which he joined in 1926.

Professor **John A. Gibson, Jr.** died July 30, 1989, in Morgantown, W. Va. He graduated from Allegheney College, Pa., in 1922 and got a PhD at MIT in 1926. He taught analytical chemistry at West Virginia University in Morgantown from 1926 until retirement in 1967. He left his wife, Eleanor, two sons, and a daughter, all of whom have PhDs. He was active in many professional societies and in town societies. . . . **Alfred D. Petterson** of Bridgeport, Conn., died October 26, 1989. He left his wife, Elsie, three sons, and ten grandchildren. He was very active as an industrial consultant to many companies and organizations.

Thomas I. Dowling, Sr. died in Washington, D.C., on August 30, 1989, in Sibley Memorial Hospital. His son, Thomas, Jr., lives in Washington. His father was a Cocoa Beach, Fla., resident for 21 years. He was the patriarch of the Chapter of Barbershop Quartet. He was a navy commander during World War II and in charge of shipping all ammunition for the European theatre from New York Harbor. Singing tenor was his greatest pleasure. . . . **Peter Bellaschi's** latest material was forwarded to me by MIT. He is concerned that fewer and fewer students are preparing to teach mathematics and science in junior and senior high schools. The pay is a strong reason. Those who enter often change from future teachers to business courses, he says. . . . **Morris Minsk** gives me a ring every now and then, and we have a nice chat. . . . **Crocket A. Harrison** of Grove City, Pa., sent me his 1989 greetings at Christmas. After 58 years, he lost his wife, Fanny. He sent a picture of Imogene, whom he knew in 1921. They were reunited, married, and have traveled considerably during the past year. I agree that he was wise. Mary and I are enjoying very much starting our 17th year of remarriage.—**Donald S. Cunningham,** secretary, 27 Lowell St., Braintree, MA 02184

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Following last issue's report on Nobel Prize winner **Charles J. Pedersen,** we have to report his death on October 26, 1989, in Salem, N.J. A self-described "hands-on" industrial chemist, he spent his 42 year career at DuPont in New Jersey and Delaware, where his research yielded 65 patents, mostly in petrochemicals. Early in his career, he contributed to the development of Neoprene, the first commercially successful synthetic rubber. DuPont Chairman Woolard said, "After winning the prize, he inspired everyone else with his dignity, his humility and his personal charm."

Nathan Cohn died on November 16, 1989, in Scottsdale, Ariz. He received the 1982 AIEE Edison Medal, "for a career of creative contributions and leadership in the instrument, control and process computer industry in the control and economic dispatch of power in large interconnected electrical systems." Other awards Nat received were the Franklin Institute's Wetherill Medal, Instrument Society of America Sperry Medal, the Scientific Apparatus Makers Award, and an honorary Doctor of Engineering degree from Rensselaer Polytechnic Institute. Nat served on MIT's Visiting Committee for Libraries and Philosophy, and he was chairman of our 60th reunion. He retired as executive vice-president of Leeds & Northrup Co. in 1972.

Yuk Wing Lee died on November 8, 1989, in



Nathan Cohn

Belmont, Calif. He was Professor Emeritus in the MIT Department of Electrical Engineering and Computer Science. Professor Lee was internationally respected for his work in statistical communication theory. In 1947, he offered the first graduate course ever given in that subject. It was based on the ideas of the late Norbert Wiener, under whom he had studied and later collaborated. Lee's long association with Wiener led to the publication of "Nonlinear Problems in Random Theory," the first book on the subject in English. It came about when Wiener gave a series of lectures at which Lee took photos of the blackboard filled with equations. About 400 photos were made and a tape recorder caught every word. These pictures and text became the book. Lee was author of "Statistical Theory of Communication" in 1960. He received the honorary degree of Doctor of Applied Sciences from the Catholic University of Louvain, Belgium.

Grenville B. Gerrish died on September 25, 1989, in Melvin Village, N.H. He made an active career in sales, manufacture and consulting in food baking equipment, freezing equipment and air quality. He held patents on drying ovens for producing egg cartons and was a life member of the American Heating and Air Conditioning Engineers Association. Brad (from his middle name) and wife Madeline moved to New Hampshire on Lake Winnipesaukee in 1975.

Paul J. Harrington died on June 18, 1989, in Westfield, N.J. He graduated from Notre Dame University in 1926 and received his Chemical Engineering M.S. at MIT in 1927. Paul was a national pole vaulting champion under coach Knute Rockne and in 1927 was the first American to win the Outstanding Performance Award at the Millrose Games. His career was with Exxon Corp. for 30 years, and he was chief engineer of Esso Engineering in Linden N.J. His last four years before retirement were with Exxon's refining coordination department in New York City. He was a member of the American Petroleum Institute and on the Advisory Council of Notre Dame from 1958 to 1985.

We regret the delay in reporting the death of **John P. Engel** of Stratford, Conn., in March 1988. The message came from his daughter Elizabeth Birge. We have no information except that he was General Superintendant of the Sapolin Paint Co. in Brooklyn.

We offer our condolences to the widows and families of these fine classmates.

We also report the death of **John D. Crawford's** wife, Lane. They were married in 1930. They both attended our 55th Reunion. We extend our sympathy and best wishes to John.—**John C. Burley,** secretary, N. River Rd., Epping, NH 03042; **Lawrence B. Grew,** assistant secretary, 21 Yowago Ave., Branford, CT 06405

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First, may we express our deep appreciation for the holiday greeting cards and notes received from so many of you. It is one of the real compensations of the class secretary's office and a time when class notes material can appear in some abundance.

A letter from Mary and **Max Parshall** tells us that they are still managing very well together although it becomes increasingly difficult for Max

to move about. They are learning to make good use of employed help. An allergic reaction precipitated a health problem for Mary last October but after three weeks she was making a good recovery. They love to dine out and still have the capability. Music is important to them, and their two lovely pianos get plenty of use. . . . Gracia and **Tom Harvey** tell us of their 60th wedding anniversary dinner party last June. Children, grandchildren, and other kinfolk converged from far and wide to attend that special event. . . . **Newton Foster** writes that he and Olive now have been in Heath Village, Hackettstown, N.J. for three years, and they are active. They visited **Henry "Nap" Lacroix** recently in a nearby hospital. Nap and Gertrude have bought a house next to their daughter in West Orange, N.J.

Eleanor Pepper sent her cheerful holiday wishes via telephone. She continues to be very busy with her professional work in architecture and teaching. Her health, apparently, is still good. . . . Velma **Worthen** also called us by telephone and just after the big 1989 California shakeup. Her home in Santa Rosa, 50 miles north of San Francisco, took a severe rattling with books falling from their shelves, but no injuries. . . . Jan **Chamberlain** Fisher, in her holiday greeting sent the exciting news of her marriage to Harold "Bud" W. Fisher, '27, a friend and neighbor of 20 years standing. Obviously, we must now share her with another class although one close to us. Jan, here's to your continued happiness!

Significant honors still come to our worthy classmates. On October 24, 1989, **George Chatfield** was the recipient of the George Washington Honor Medal of the Valley Forge Chapter of Freedoms Foundation at Valley Forge, Pa. This national award is "intended to recognize the voluntary actions of individuals and organizations who serve as examples of responsible citizenship, offer solutions to contemporary problems or promote the benefits of a free society." George's winning project was "Promoting an Understanding of our Freedoms." The presentation ceremony must have been an impressive affair with a color guard, Cadet Glee Club, reading of citations, presentation of medals (with small American flags attached), photographers, black tie, etc. all followed by a fine reception. Marie and George made the 1,200-mile round-trip from Rindge, N.H., for the occasion while son Don flew down from Chicago to attend. To you, George, our hearty congratulations!

Then on September 22, 1989, at a Copley Plaza black tie dinner marking the 75th anniversary of the Founding of Peter Bent Brigham Hospital in Boston, Mass., a citation was read and presented (along with an Orrefors crystal bowl) to Frances Cooper-Marshall **Donovan** recognizing her 50 years of volunteer service to the hospital. The citation by Board of Trustees Chairman Alan Steinert, Jr. reads: "She became a 'Friend' and in many more ways than one, exactly 50 years ago this year, and was the second of their distinguished presidents. This Phi Beta Kappa graduate of Radcliffe has been an island of calm during the Brigham storms, a haven for seekers of advice and counsel, and a beacon for those of us who have been in need of direction. Her serene self-deprecating demeanor camouflages a steel trap mind, a rock-solid backbone, and an iron will that has served the trustees of the Brigham and its overseers nobly in the several decades she herself served as both. Frances Donovan elegantly and effectively championed the causes of all the many female constituencies of the Brigham from physicians to nurses, especially the School of Nursing, dieticians, Friends, and young spouses of our staff as they all sought recognition and their rightful place within the hierarchy, with skills honed as chair of the committee to merge Radcliffe with Harvard. No one could have been or could be more perfect for us." Our hearty congratulations to you, Fannie!

With deep regret we must now report on three class-related deaths. **Charles Watson Newhall, Jr.** died November 18, 1989. Watson graduated in Course 6, electrical engineering, then studied finance and statistics at Northwestern University to earn his MBA degree. His business career was as a financial executive for engineering companies, mostly with Public Service Co. of Northern Illinois and then with Rockefeller Venture Capital Group. During World War II, he served for five years with the U.S. Air Force as colonel and pilot. Watson's wife, Brant, graciously and thoughtfully sent us a copy of his memorial service program. . . . **Walter Brundage Dean** died May 30, 1989. His brother was most kind and sent obituary details to our Alumni Office. Walter graduated in Course 2, mechanical engineering, and made his professional career with the Budd Co. doing development, design, and production work on rail and highway transport equipment. He became widowed in 1941 (wife, Brigitte) but leaves three sons and a daughter. . . . **Harold E. Edgerton,** '26, our honorary classmate, died suddenly on January 4, 1990, just as these notes were being prepared. "Doc" has been very special to our class over the years and will be remembered as a lively participant in many of our reunion activities. The class was represented at his memorial services and has made a contribution to his memorial fund. We extend our heartfelt sympathy to the families of these, our departed classmates.—**Walter J. Smith,** secretary, 37 Dix St., Winchester, MA 01890; **Ernest R. Knight,** assistant secretary, Box 98, Raymond, ME 04071

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Chung Foy Yee of China, presently of Worcester, Mass., writes, "I am so glad to have met you at our 60th reunion last June. I enjoyed myself greatly and like the scheduled programs.

At this writing, the weather in Massachusetts is very cold. You are very fortunate to be in Florida where the climate is much warmer." . . . **Joaquin J. Llanso** of Woodlands, Tex., writes, "Despite some health problems, my wife, Dorothy, and I continue to lead a fairly active life. Recently, with the help of our son, Martin, who did all the driving, we toured by van 16 states and covered 4,500 miles. It took us two weeks, and we went home to recover from our fatigue."

Eric Bianchi of Jupiter, Fla., who attended our 60th reunion with his new wife, Helen, sends a note: "Helen had her knee operation last October and six weeks later was dancing around, but no golf yet. The doctor says another month more. She has made a wonderful recovery." . . . From **J. Wesley Walters** of St. Paul, Minn.: "On June 27, my wife, Josephine, and I celebrated our 60th wedding anniversary. We still hike between two and three miles daily and still do a considerable amount of travel by car as the spirit moves us. Thanks again for all the work you have been doing as class secretary. Best wishes always to you and all our classmates."

I have a note from **Frank Mead** of Northport, Fla., and Marion, Mass., who lost his wife, Mary, last spring: "It has been a dreadful year for me, my dear wife ill and dying and then losing a sister this past summer. I got my boat in the water at Marion but didn't use it. Have given up lobstering. Had a good fishing trip to Brunswick with a friend. Hooked three salmon but didn't pull in any. Have returned to golf here in Florida. Also played golf at Marion, which helped me to lessen the pain of losing my wife. Sorry to have missed our 60th reunion. Give my very best wishes to our classmates, and many thanks to you for a grand job you are doing as secretary."

At this time, I would like to tell you how I got to be your class secretary. During our 40th reunion in 1969 at the Cape, Frank Mead was class president and a great friend of mine. Just before our business meeting, he told me that he had nominated me for class secretary and please not to say no. I protested that I had no particular talent in that field, but he said to try it and see. I learned shortly that the hardest task of a secretary was to get news from the members. I used to send 10 letters and get one reply back. Then I conceived the idea of sending a birthday card to every member with a self-addressed envelope and a reply sheet asking, "What is new with you?" That did it. Soon I had more news than my alloted space. In my 18th year of being your secretary, I was pleasantly surprised to be informed by the Alumni Association that I had received the coveted Harold E. Lobdell '17 Award for my work as secretary. Mary Mead sent me a nice letter of congratulations with the comment, "You are the fellow who said you had no talent in that field!"

Edward R. Godfrey of Huntington, N.Y., writes, "All is well with me, though my wife is quite frail and needs my constant care. Out of 11 grandchildren, none are married yet. They range from 2-30 years of age. I have just retired from sailing and have to find a new hobby soon." . . . **Rolf A. Zurwelle,** of Forest Hill, Md., is considering closing up his business soon. Presently, he is offering free design of houses and free consultations on any engineering problems to friends who may need it. . . . **Amasa G. Smith** of Birmingham, Ala., writes, "It would be interesting to know how many of us are active and living? I certainly enjoy reading the *Technology Review* articles and of course the class notes. We do not have much exciting news, but we are leading an enjoyable simple life and pray that it will continue for many years. Best wishes to you and all the classmates."

Many of our classmates have asked the same question—how many of us are still alive? Our graduating class was about 750, but the Alumni Association has included, as a matter of policy, many special students who took a single subject for a half-semester. As of September 25, 1989, the roster of class of 1929 lists 240 members, of which I estimate 40 percent in the special student category, leaving 144 members living out of the original 750 in 1929.

Harold W. Weddle and wife Esther of San Diego, Calif., who were at the 60th reunion, send a note: "Sorry to hear about the death of **George Crandall.** We remember him and his wife, Willa. After our reunion trip, we flew to Helena, Mont., to spend a week with our younger son. In October, we went to Kansas to visit relatives and other townspeople. Esther and I met while attending Kansas State University. Esther and I send our best wishes for the New Year to you both and to all our classmates." A few years ago as our class members were becoming octogenarians, Harold sent me a very timely and humerous poem, "Life Begins at Eighty," which was published in our class notes. Harold modestly corrected me at the recent reunion—he wasn't really the author but received it from a friend and sent it for a good laugh. . . . **Paul F. Donahue** and wife Fran of Nahant, Mass., enclosed a note with their Christmas card including a beautiful family picture comprised of Paul and Fran in the center surrounded by the rest of the family, numbering 16. They write: "We were unable to attend the reunion because of Paul's hospitalization at the time. He is all right now. Best wishes to you and all the classmates." . . . We also received seasons greetings from **Jerry Gardner,** of Belmont, Mass., our new class president, and his wife, and from **W. Gordon Bowie,** of Oldstedville, N.Y., our class agent, and his wife, Sally. . . . **Bob Pride** and wife, Marion, of North Palm Beach, Fla., were our house guests for the weekend of our 60th reunion. He and I went through Somerville High School together and took the same course at MIT. Our friendship covers over 60 years.

Richard Piez of San Mateo, Calif., sent Christmas greetings with a note that 1988 and 1989 had been years of extraordinary changes. He says, "After the death of my second sister, I decided that it would be better for me to move into a retirement home and sell my house and most of our furniture and extra items. I have completed the task. My speed ranges from 'slow ahead' to 'stop.' The Penninsula Regent, my present retirement home, has 207 apartments, all occupied currently. To my knowledge, everyone is pleased



with conditions here including myself. Let us not hurry to the 65th, but let time slowly take its course and hope to be around when the time comes."

I have received a sad note from Brig. Gen. **J.E. Howarth, Jr.** of Arlington, Va.: "It is with great regret and sorrow that I have to report the death of my dear wife, Marjorie, after more than 51 years of a happy marriage." Your secretary has expressed sympathy to the general on behalf of our class.—**Karnig S. Dinjian,** secretary, P.O. Box 83, Arlington, MA 02174

30 60th Reunion

Plans for the 60th Reunion are proceeding on schedule. **Yicka Herbert, Ed Pritchard,** and **Greg Smith** met with members of the Alumni Association staff early in December to work out final details of the program and costs. A letter including these details and registration materials is scheduled for mailing soon.

This month we have a report from **Joe Kania,** one of our most prolific communicators. Joe's extensive travels for the Vancouver Board of Trade and his unique polygonal Vancouver house, affectionately called "Kania's Kastle," have been previously reported. It now appears that his first wife, Nan, died about two years ago and he has since remarried. He and Nan, who worked for Professor Gillson in the Geology Department, met and married while Joe was at MIT. Joe sold Kania's Kastle last year and he now lives in a "lovely condo." He and his new wife, Florence, are planning a motor trip through New England in June and look forward to attending the reunion. . . . Now that we are in our 80s we are acquiring an increasing number of great-grandchildren. **Bill Cullinan** reports from Cape Elizabeth, Maine, that he has five, a bit short of the seven that **Bob Quinlan** reported last year. Bill and his wife, Janet, spend the winter in Ft. Pierce, Fla. . . . **Mo Shaffer** and his wife, Nargaret, do a considerable amount of travelling and "enjoy a leisurely life in New Orleans, where a multitude of friends and abundance of cultural activities keep us from being bored." The Shaffers are "thinking about attending" the reunion next June. (In preparing this item I noticed that Mo was born in February 1910 and thus appears to be our youngest survivor. Do you know of anyone younger?)

Again this month we have notices of the deaths of several classmates. A note from Priscilla Ferguson Stauffer brings the sad news that her father, **Earl Ferguson,** died on October 13, 1989. Earl worked for New York Telephone Co. for 40 years, largely on financial analyses of company properties, and retired in 1970 as an assistant vice-president. His retirement activities included tax counseling of the elderly under the AARP program, photography and extensive travelling. Earl's wife, Hilda, who regularly attended reunions with him, predeceased him by about six months. He is survived by Priscilla and a granddaughter, Pamela. . . . **Charles Gale** died in LaGrange, Ill., on September 18, 1989. He worked for many years for American Oil Co. and retired in 1968 as manager of publications and advertising. After his retirement he made an extensive investigation of the history of the Gale family, which apparently settled in Oak Park, Ill., in 1833, and he found some 600 family members. As a result of this activity he became president of the Oak Park and River Forest Historical Society. He was also a director of the Frank Lloyd Wright Home and Studio Foundation. My records indicate that the Gales had no children; he is survived by his wife, Kathryn, to whom he was married for "59+" years. . . . **John Weaver** died in Spokane, Wash., on his 82nd birthday, October 9, 1989. Unfortunately, I do not have much information about him. When I last heard from him in 1971 he owned and operated a company that made "plastic film heat exchangers for use in open heart surgery." The latest Register indicates that he continued running this company until shortly before his death. I do not have any information about his family.—**Gordon K. Lister,** secretary, 294-B Heritage Village, Southbury, CT 06488

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In early December I saw in a Letters to the Editor column one from **John T. Harrison,** who retired from the hardware business and now lives in Durham, N.H. He was taking state officials to task for resisting an increase in electric rates by the Public Service Co. of New Hampshire and in opposition to the New Hampshire statute that prohibits including a plant under construction in the rate base until it goes on-line, now that the Seabrook plant is close to being on-line. This statute plus the many changes dictated by the NRC, and the final blow—the requirement of an evacuation plan for all communities within 10 miles of the plant—have more than doubled the cost of the plant and prevented its going on-line until the evacuation plan is approved. The effect of the changes and the delay on the cost basis can easily be guessed by those familiar with the buildup of interest accumulation. In fact, it bankrupted the Public Service Co., but neither the New Hampshire legislature, the governor, nor the NRC will take any of the blame, and oppose any increase in rates until the plant has a full-power license.

John got me to go along with him to a hearing before a special commission to set the rates for the Public Service Co. for the benefit of the referee in bankruptcy. An interesting hearing, and also interesting that Mrs. Bisson, the only woman on the commission, is the daughter-in-law of Reginald Bisson, '30, who many of us knew at MIT.

One note came in from **Charles Broder,** who writes that he is enjoying retirement in North Carolina with his son, Dr. Michael Broder, daughter-in-law Susan, and three grandchildren. He is still going strong and fully expects to be at our 60th reunion in '91. We remember seeing him at Ford Ord, Calif. when, being reservists, we were serving our active duty after receiving that "on-year" recall, which in my case became five years.

Mildred and I took a trip to visit her relatives in Arkansas in October, and stopped off in Lexington, Ky. for a reunion of the 35th Engr. Reg. & Bn. & 145th Bn. (formerly 2nd Bn. of the 35th). Had a great time recalling events on the pioneer road construction on the Alaska Highway (Fort Nelson to Watson Lake) and Canol Road (from south of Whitehorse toward Norman Wells) and later with George Patton's 3rd army. One of those there remembered my birthday, so the last day of the reunion (October 7) they surprised me with a birthday cake one day before I turned 81. (I was the oldest one there.)

Will have to conclude with the sad news we all have to confront sometime after age 80. **Robert H. Baxter, Jr.** died December 6, 1988, and is survived by his wife Dorothy M. Baxter, 3401 Townsend Blvd. #10, Jacksonville, FL 32211. Robert served as an industrial engineer with the Rexall Drug Co., and he served in the army during World War II. He is also survived by a daughter, Joyce H. Wells; a son, Brigadier General Robert H. Baxter, USAF; and four grandchildren, Christine and Kelly Baxter, and Brit and Chad Wells. I well remember him on our Field Day football team—a really nice chap.

Ronald J. Jameson died March 1988 in Newport, Maine. He is survived by a brother Paul, but we have no further information. . . . **David B. Lawrence** of New Orleans passed away May 11, 1988, but we have no information other than that he had been president of Milliport Investment Corp. . . . Another death is that of **Frederick V.C. Branch** (7667 Callaghan Rd., #102, San Antonio, Tex.) in July 1988, reported by Mrs. Frederick V.C. Branch. He was retired from IBM.

The demise of **Raymond Jacques** on October 26, 1989, was reported in the *Sun Chronicle* of Attleboro, Mass. His wife, Margaret Griffin Jacques, predeceased him. He had been employed by Polaroid in Cambridge for 35 years, and was a past Grand Knight of St. John's Knights of Columbus in Attleboro. He is survived by a son, Joseph Jacques of Lakeville, and two grandchildren.

Our felicitations go out to the Class of '31 survivors, and we can refresh our memories with the many interesting moments we had with them at MIT. Which reminds me of a comment made at a recent Rotary meeting by Skip Lockwood, a former professional ball player (now in life insurance) who attended Sloan School (SM, '83). He said that studying at MIT was very "like trying to drink from a fire hose."

Wife Helen says that **Ed Worden** is home now and greatly improved. Reading and writing are difficult for him, and his eye doctor says it may be another year before he can operate. Helen is happy to have him home and he is happy to be there.—**Wyman P. Boynton,** secretary, 668 Middle St., Portsmouth, NH 03801

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It was heartwarming to receive Rose and **Tom Weston's** New Year's greetings including a printed newsletter on their 1989 activities. They derived much pleasure from sharing experiences and games with their grandchildren. When the mini-reunion cruise for our class fell through, the Westons, undaunted, boarded the *Caribbean Prince* for a beautiful trip through the islands where they found time for swimming and snorkeling. They also did a lot of traveling through Scotland and England and then to Holland where they attended the fourth meeting of the International Congregational Fellowship at Liewenhorst.

They are looking forward to meeting as many classmates as possible at our mini-reunion at MIT this June. A very interesting program has been planned, and all those who attend will not be disappointed.

We were happy to hear from **Robert Follansbee** who writes, "For the past 10 years, Sue and I have been 'skimmers' enjoying six beautiful months in Maine and the other six warmer months in Venice, Fla. We particularly enjoy the monthly meetings of the lively MIT Club of Southwest Florida whose membership includes the following classmates: **Kip Adams, Manson Benedict, Phil Benjamin, Bob Crane, Albert Daytz, Jack Millman, Henry Mitchell, Alfred Mulliken,** and our very special girl member **Kay Sarabia,** who is now Mrs. Sam Burrows. Sam, '31, somehow got ahead of the rest of us!"

It is my sad duty to report the passing of several of our classmates. **John M. Graham,** 79, died in September 1989 at his home in Darien, Conn. He was an engineer and executive for the Esso Eastern Chemical Co. until he retired in 1969. He served as a Sunday School teacher and assistant treasurer for the First Congregational Church. Among his many civic duties, he was a statistician for the United Way. He is survived by his wife, Ruth, three sons, and six grandchildren.

Eugene C. Kitendaugh, of Oneida, N.Y., died on March 9, 1989. He was employed with Oneida

ILLUSTRATION: JOHANNA SCHWARTZ

Ltd. as an electrical engineer. He is survived by his wife Louise, one daughter, one son, six grandchildren, and two great-grandchildren.

Arthur Bishop died in November 1989 in South Yarmouth, Mass. He lived in Dennisport. He retired in 1979 as an engineer for Raytheon Co.'s electronic division. He leaves a daughter, a grandson, and his companion, Edith B. Wood.

D. Dana Price died in Houston, Tex., in October 1989. He was the owner and operator of his own consulting business for many years. He was active in many professional and civic organizations. He is survived by his wife, Mildred, two daughters, two sons, and a grandson.

We also have received word that the following have died: **Robert West,** Silver Spring, Md., in November 1988; **Robert Butler,** Sarasota, Fla., in February 1989; **C. Vance Hale,** Newport News, Va., in September 1989; **Peter Shelby,** Los Angeles, Calif., in February 1989; **George E. Connor,** Hingham, Mass., in September 1989.

We will print more when we receive obituary information. Please keep writing to me and send pictures.—**Melvin Castleman,** secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Obituaries: **Arthur T. Bishop** died November 7, 1989. He is survived by his daughter, Patricia Ann. . . . **Arthur A. Jackman** died October 14, 1989. His widow is Margaret J., 15 Woodland St., Whitinsville, MA 01588. . . . **William W. Laird** died October 20, 1989. He was financial advisor and a former director of Du Pont. He was also a founder of the Wilmington Opera Society and donated land for the University of Delaware's north campus. Mrs. Laird is at 1 Black Gates Road, Wilmington, DE 19803.

Herb Grier received from President Bush the National Medal of Science, for energy.

Our current champion correspondent, **Walt Skees,** reports that University of Barcelona charges $500 yearly tuition. It's so tough that about half fail, and those who wish may repeat twice if desired. The student body is about 40,000.

Jermain and **Jack Andrews** report that they decided to stay in Lawrenceville. They have redecorated and practically renewed the house and now want instructions on how to clean out the accumulation of years of stuff in the basement. If you know, please advise.

This is being typed two days before Christmas, and you are reading this in April (we think). I shall attempt to determine why the *Technology* cannot be improved in this day of instantaneous communication.

Don Winkler "has been mowing hundreds of thousands of leaves to break them up for my backyard recycling pile." . . . **Ferd Johnson** keeps very busy with garden club, hiking club, and cutting wood. He enjoyed the affair in September on campus as a guest during the awards get-together. . . . Doris and **Leonard Julian** had a busy year including Leonard having radiation for prostate difficulties. Their children are involved in music pretty heavily. Andrea was at Carnegie Hall for a concert with her choral group. They came through the California earthquake okay. Their grandson, Sam, has just become a violinist with the Dallas Symphony, and their son-in-law is establishing a practice in kinesiology, a patterning process for improving the mind, and supporting himself in the taxi business. Their daughter, Sheryl, is seen frequently in the *Boston Globe* on food and may be seen soon on PBS.

The Cardinal and Gray Society (for all alumni classes 50 years or earlier) will have activities during alumni weekend July 7-9. You should have mailed your notice prior to this, but it's never too late so do it now if your intentions are positive.—**William B. Klee,** secretary, P.O. Box 7725, Hilton Head Island, SC 29938, (803) 785-7746

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Please send news for this column to: **Robert M. Franklin,** secretary, P.O. Box 1147, Brewster, MA 02631; **George G. Bull,** assistant secretary, 4601 N. Park Ave., Chevy Chase, MD 20815

35 55th Reunion

Art Haskins reports that he has been spending almost full time as first reader of their Christian Science church. However, with son Dan's help, he was able to get "Surefire" into the water in time for the annual Casco Bay Interclubs held in South Portland on the July 15 weekend. "Due to thick fog, only two other boats entered in our class, and we took a 1st both days. Chip Faulter, my ace foredeck crew, navigated, and we never missed one of the eight-course marks. Even the trauma of an encounter with a couple of tugs and a barge in tow in the fog fades with time." Two weekends later, Art won a 2nd in the State of Maine Tanzer 22 Championships. He ended the season with a 3rd in "very close competition" at Chebeague Island. In mid-September, he gave up his readership at the church and is now clerk, on the property committee, usher staff, reading room staff, and transportation committee. Art explains, "in a small church everybody gets to do a little of everything."

Les Brooks wrote from Rockmart, Ga., complaining how difficult it is to hit a golf ball down the center of the fairway; you are lucky when it ends up there. He says, "Golf seems to be the only thing we can qualify for in these golden years. But it's better than nothing, I guess." Les reports that Ellen recovered nicely from a knee replacement last May at the Sports Medicine Hospital in Columbus, Ga., where professional athletes go with their orthopedic problems. He is still consulting several days a month, which he enjoys as it helps to keep him occupied. They are both looking forward to getting back in June for our 55th, and he will have his "sticks" with him.

Bernie Nelson is preparing for a big Christmas on the Cape with his two daughters, a son-in-law, and three granddaughters. Deborah Aylesworth is in Wellesley with her two girls and is director of religious education at St. Andrews Episcopal Church. Betsy Duenas is home with Carolyn, and Joe is technical director for Dan Rather Evening News on CBS.

I am sorry to report the deaths of two of our classmates: **Edward Helwith** last October 20 and **Bennett Beede** last December 22. **Paul Herkart, Walter Stockmayer** and Sally (Mrs. **Edward) Helwith** all supplied me with obituaries of Ed, but Stocky wrote me a long letter while flying from Boston to Denver via Minneapolis. I shall give news of his activities in the next column. Stocky says Ed was a major influence on him. He continues, "Thrown together by the accident of dorm room assignments in the freshman year, we spent sophomore and junior years as roommates in Atkinson 401." He earned a master's degree in mathematics at Columbia after graduation in Course VI-A. He worked a few years in New York City with Gibbs and Hill engineering consultants before serving in the Navy in World War II. Following that, he was an engineer at Bonneville Dam for a time before returning East to work with his father. At age 34, he enrolled in Long Island University Medical School and had his MD in four years, worked as a general practitioner 15 to 20 years, then closed his practice and went to work for the New York Port Authority in operations research.

Sam Brown sent me a note advising of **Ben Beede**'s fatal heart attack. During World War II, Ben worked on a classified project at the Watertown Arsenal. Since the late 1960's he had worked at Dwight Foote, Inc., of Ashland, a designer of materials handling equipment. He was past commander of the Trinity (Masonic) Commandery of Hudson, a director of the Hudson National Bank, and a member of the Veteran Motor Car Club of America. He was active with his fraternity, Theta Delta Chi, as one of the graduate overseers and member of the House Corporation to raise funds for the new house on Memorial Drive. He is survived by his wife, Hildreth, four daughters, a son, and seven grandchildren. I am sending our condolences to Hildy and Sally.—**Allan Q. Mowatt,** secretary, 715 N. Broadway #257, Escondido, CA 92025

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Jim (Pat) Patterson reports on the October mini-reunion: "Eleven classmates (with wives, one son, and two daughters—totaling 24) attended the gathering at **Alice Kimball**'s home in northwest Connecticut. An excellent lunch and dinner by the ladies were coordinated by Mary Assmann, and brisk walks around the pond and into the woods were enjoyed, especially by first-timers. **Towers Doggett** and Doris came the farthest, from Westbrook, Maine, and were weekend house guests of **Eli Grossman** and Vivienne. **George Parkhurst** brought along his pictorial history *Chelmsford, The Town and Its People,* published last July and sold out in three weeks. George and Barbara have roots in Chelmsford dating back to 1654, and have a museum of local mementos in their condo, built on property that has been in Barbara's family since 1680. George has written 109 consecutive weekly articles for one of the local newspapers.

"While Hulda played bridge with other wives, **Phil Gilinson** related that they left Beijing, China, only two days before the massacre there last June. Phil had been the honored guest (all expenses paid) at the International Symposium on Inertial Technology. This was the latest of a number of visits, sometimes for three months, in recent years. Phil went to work for Dr. Charles Draper, our late, great professor of aeronautics, and finished as associate director of Draper Lab in 1980. On a visit to China that year, Dr. Draper was asked to recommend a practical-type individual to teach Chinese scientists and engineers. Hence Phil's China connection. . . . In their new Brooklin, N.H., residence, **Milner Wallace** and Robin continue community activities. Milner has joined the conservation commission, which rules on construction projects before consideration by the planning board.

"As an introduction to the meeting, Alice read a poem written by her father, Frederick Hunter ('02, Course IV), 'Doings of a Freshman.' It appeared in the 1902 *Technique* and was later put to music by Winthrop Packard, '83 (1883, that is), and included in the MIT songbook as 'Teddy Freshman.' The words could have applied to us and would likely fit today.

"The mini-group felt that the general pattern of our 50th reunion would work well for our 55th in June 1991: Wednesday or Thursday to Friday in Cambridge, Friday dinner and Saturday and Sunday on the Cape. Sentiment favored Chatham (good weather this time, please!), but let's hear from the rest of the class. First mailing to the class will be this fall. So keep early June 1991 in your date books, and urge classmates to attend also when you correspond with them." Thank you, Pat, for the report.

My November-December class notes stand corrected by **Bill Hastings,** who wrote me immediately in the following terms: " did not drop out the first time around. I flunked out then, too. The first time, Pop Drisco gave me an F in 8.01; the second time, he gave me an FF. I managed to hold my own with an L in Dr. Salstrom's 5.01. I have had three great teachers in my life, including Leonard Passano (in math at the Institute), and only two gripes: an English instructor who flunked a paper for misspellings only, and PT emphasis on posture. *Nichtdestoweniger* (nevertheless), the Institute is the greatest school of its kind and I consider myself lucky to have been exposed to it even minimally. I still know my

Woods and Bailey (up to about page three). I found that I was able to invent partial differentiation for something I was doing in econometrics. Just being exposed to Tubby Roger's recitation of 'Mumbo Jumbo God of the Jungle' was worth the price of admission."

Boris Maximoff in Los Altos, Calif., followed up our earthquake conversation (see last issue) with a letter: "Retired five years and seem to have become a student of economics and investments, but this is back seat to home, garden, and auto repair chores. I do a bit of hiking on the local Santa Cruz mountain trails and on rare occasions venture into Sierra Nevada. If any classmates should be visiting the San Francisco area, I would be happy to have them stay with me."

Connie Bouchard (Course II), although retired 17 years from Ford Motor as executive engineer, hasn't let up on things mechanical. He writes: "Enjoying a hobby restoring for myself many exotic classic cars, including several Rolls Royces, a 540K Mercedes Benz, a 1927 three-liter Bentley, etc. I also make from scratch all parts for various British-type skeleton clocks. All alumni are invited to come visit my shop and cars at 579 Tooting Lane, Birmingham, MI 48009."

Homer Webster, captain USN (retired), Course XVI, replied from Hanalei, Hawaii, to the Alumni Association: "All systems A-Ok." On the telephone he told of being in Course XVI only one year, after two years at the University of Kansas, then transferred to Tufts and entered the navy in his senior year. After retiring he went into the space program at Cape Canaveral and set up tracking units down the South Atlantic trajectory of liftoffs. . . . Homer and **Mike Kuryla** (deceased '86) were close friends, having played football together at Exeter. Mike's distant home in Mexico precluded spending Thanksgiving and Christmas with his folks, so Homer's family in Mass. had given him a home away from home. . . . **Bill Prichard** (Course XV, deceased '67) and his family in Swampscott had done the same for me on Thanksgiving.

Stan Robbins (Course VII) wrote: "Am still teaching at Harvard Medical because I haven't got time to think about quitting." Indeed he doesn't! At 9:15 EST the day after Christmas, he was already in a meeting at Brigham and Women's Hospital, and the following morning when I called he was about to leave for another busy day. Stan got his MD at Tufts Medical School and later taught for 30 years there, retiring as chairman in 1980. Then he was asked to be visiting professor at Harvard Med, and he is still at it. Was there something about Tech's pre-med that fostered teaching doctors? Stan spoke of **Melvin First,** professor at Harvard School of Public Health, and remembered **Ed Pratt** (deceased '88) while still teaching at Childrens Hospital in Cincinnati.

Months ago **Bill Rousseau** obliged me with items from his 1988 year-end roundup of letters from Course X-Aers, and I have been slow in getting the following squibs into class notes: **George Dummings'** third trip to the Soviet Union had an extra bonus—the Reagan-Gorbachev summit occured at the same time, with much excitement among the Moscow citizenry. With all that has happened to the East Bloc in 1989, I imagine George can't wait to go again. . . . **John Roberts** and Jane, on a cruise around Italy, had **Al Horton** (also Course X) and Gabrielle as nextdoor cabinmates. . . . **Jim Seth** in 1988 pursued his hobby of archeology in my own back yard, so to speak, in central New Mexico and in the northwest area called Four Corners (where four states meet), followed by sight-seeing in Santa Fe. . . . **Bill Rousseau** visits Course X-A practice schools twice a quarter and reports: "It certainly is gratifying to see the enthusiasm of the students. They work as hard as we did and because of computers accomplish even more. Also, they land the cream of the jobs when they get their degrees."

Let's raise our glasses and cheer the lives of **Ed Ferris,** Course XVI; **Charles Shubart,** also XVI; **Bill Shockley,** VIII; **Norman White,** XVII; and **Martha Hathaway Williams,** XVIII. . . .

Newspaper clippings from *Greenwich Time* and *Greenwich News,* the latter from neighbor **Bill Hastings,** tell of Ed's death October 31 after a dauntless struggle (see November-December '89 notes). Ed grew up in the Ferris farmhouse on Post Rd., Greenwich, which may have survived from his forebear Jeffrey Ferris, first settler in 1639. Ed's widow Evelyn continues at 9 Grimes Rd., Old Greenwich, CT 06870. . . . **Charles Shubart** died October 23, 1987, of heart ailments after suffering Parkinsons and Alzheimers diseases. His career in aeronautics took him to Australia, and after wartime duty as navy lieutenant commander, to the Bureau of Aeronautics. Widow Irene's sister Bonnie eulogized his humility, courage, and self-discipline: "Giving his time to family and friends, asking only in return that they use their God-given gifts to make this world a better place." Irene continues at 6447 Woodridge Rd., Alexandria, VA 22312.

Bill Shockley, one of the Bell Laboratories trio who won the Nobel Prize in physics in 1956, died August 12, 1989. Theirs was an exercise in pure science, investigating the properties of semiconductive materials, from which came the transistor in 1948. As one of the three was later quoted: "Little did we realize then what a revolution in communication this would cause throughout the world, making a source of news available even to a camel driver in the middle of a desert." It further enabled a quantum leap in the productivity of just about every endeavor. Bill joined Course VIII after an SB from Stanford, and got a PhD in physics. . . . **Norman White** followed his building and construction engineering education throughout his career, first with the family business and later with his own N.K. White Construction Co. Numerous buildings in and around Boston attest to his professionalism. As a consultant on the 180 Beacon St. building, Norm insisted on coping with watery subsoil conditions by a method that attracted much attention. His widow Doris spoke of Norm's looking forward with hope even the day before his death December 7, after a long bout with schlerosing cholangitis. He was planning to learn Chinese! She lives at 30 Hagen Rd., Newton Centre, MA 02159. . . . **Martha Hathaway Williams,** who died July 22, joined the class as a graduate student, and got an SM and PhD in mathematics. She was married, retired, and living in Delawre for many years, raising her children, Sarah (Yourshaw) and Jon. Martha held office in the National Council of Garden Clubs at local, the state and regional levels, and also in the American Needlepoint Guild.

Phoebe and I are selling our condo and purchasing a house March 1 about two miles from the Santa Fe Plaza. Our telephone number will remain (505) 988-2745, but please make a note of the address below, and let Pat Patterson or me hear from you.—**Frank L. Phillips,** secretary, 1105 Calle Catalina, Santa Fe, NM 87501; **James F. Patterson,** assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Please send news for this column to: **Lester M. Klashman,** secretary, 289 Elm St., Apt. 71, Medford, MA 02155

38

Poor **Don (Severance)** is working really hard
To try and get some news,
He writes requests to many folks
But answers they refuse.
Bill Brown was different this time round,
He travels overseas,
Two months in England's Cambridge town
And now Hawaii's breeze.
He spends a little time at home
Programming Macs for Sue,
Along with an astrophysics course
And volunteer work, too.
Earle Lovering is volunteer,
Executive Service Corps,
He helped Mexico's Cobrecel
To make their costs much lower.
Ray Epstein's writing's worse than mine,
I think here's what he said,
Of Epstein's sons—a worldwide firm—
He's now retired as head.
Ray has homes in Paris, France,
And Acapulco, too,
When he and Betty travel far,
Chicago just won't do.
Nantucket is the present thought
For Reune 55,
Sunday-Wednesday, then come back
To Cambridge, if alive!
Please write and tell us of yourself,
Your travels, hobbies, life,
Classmates you've seen, fond memories
Of husband or of wife.

—**Ed Hadley,** assistant secretary, 50 Spofford Rd., Boxford, MA 01921-1504; **Don Severance,** secretary, 39 Hampshire Rd., Wellesley Hills, MA 02181

39

Joe Dana and Jean write, "Just spent three great weeks in France. Bare-boated on the Canal du Midi with two other couples for a week, then through Provence area and Loire Valley for finale in Paris. Amazingly, my High School French got us through this unscheduled tour. . . . **Barry Graham** and Jean write, "After that marvelous 50th, what's for an encore? We enjoy being South (!) in Toronto for the winter with family and friends." . . . **Win Reed** and Margaret continue in good voice and eagerly await **Fred Cooke**'s introductory G-seventh at our next singalong.

George Cremer reports *Optics Magazine* carried **Richard Feynman's*** picture on its cover and devoted 50 pages inside to his achievements. . . . **Paul Stanton** and Dora sent a color photo of a '39er group engaged in attitude-adjustment activity before the barbecue at Chatham. They write: "Just think! The 55th is only 4.5 years away. In the meantime we are busy just trying to stay retired. Come see us and have a mini-reunion with **George Dadakis, Wiley Corl,** and **Sid Silber.** I see Wiley at Shrine Club meetings, and George lives nearby. Sid and Jean are due down here (DelRay Beach, Fla.) very soon." . . . From **Bob Touzalin** and Aletta: "We had another great European trip. Weather was superb, with rain only 1.5 days in 3.5 months. Had a fine trip along the coasts of Normandy and Brittany and then along the Loire and over to Mt. Blanc."

Ernie Kaswell and Yolande are in a several-month trial run of living in Reston, Va., prior to a possible migration from Waban. . . . **Seymour Sheinkopf** and Sylvia moved to Burtonsville, Md., and enjoy being closer to family. . . . **Manning Morrill** and Connie completed their wrap-up of our 50th reunion and had enough energy left to create a Christmas letter with incidents related in lighter vein.

Ted Wroblewski is featured in a five-column article in the *Danvers* (Mass.) *Herald.* Centerpiece of this article is a three-column picture of Ted leaning back in a swivel armchair in his den where he researches ballasts and transformers such as those used in fluorescent lamps. The lead reads: "Wroblewski is sought by law firms from all over the country to testify as a technical expert on ballasts and causes of electrical fires." The article describes some of Ted's fascinating investigations.

Morrie Nicholson and Norma are both still "Scouting," Boy Scouting and Girl Scouting, that is. Their Christmas card was special—green on white—two silhouettes, his and hers, bring to mind an Alfred Hitchcock intro to a TV mystery show. There was a miniature logo of the plaque given only to those who create significant long-time benefits to Scouting. A fatigue hat was sketched with "MIT 39" and the legend "50th class reunion" underneath.

Jim Barton and Mary completed their record-breaking fund-raising effort on behalf of our class. We all recognize this achievement, and we thank them. Mary continues with tennis when it is not interrupted by minor domestic tasks such as re-carpeting the house and managing replacements of major equipment units. Jim has been applying hours of his time, again to benefit MIT. This time it's for MIT's new Road Show project.

The Road Show is to be held during 1990 in eight cities including Seattle, San Francisco, Los Angeles, Chicago, New York, Detroit, Houston, and Washington, D.C. Ideas to be presented in the eight shows are summarized in the book *Made in America, Regaining the Competitive Edge.* Selected mailing lists are to be the basis for invitations to the shows. Classmates desiring to help and attend may call the program chairman of the nearest MIT alumni/ae club.

John Alexander and Nancy shared an evening of pleasant harmonies with Hilda and me at a performance of Seattle's top-flight Barbershop Champion Chorus and its quartets. John showed me another of his impressive hobby implementations. This one started with John's curiosity about solar cells. He knew generally that radiant energy (as from sunlight) can strike a solar cell where some of the energy is converted to electricity that can be captured and used. John was curious to know (quantitatively) how much electric power is produced by a solar cell, under what conditions, and at what rate.

On the workbench next to his ham radio in the garage, I saw what he did to find out. John's apparatus was mounted on a plywood slab about 12 inches square. Along one edge were four solar cells, each about 1.5 inches on a side and connected in series. From the cells there was a maze of wires to a load unit with a variable resistor. A voltmeter and ammeter were connected. With this rather-unsophisticated assembly of elements John expected to develop a series of curves to show precisely the operating characteristics of small solar cell generators.

I admired John's tiny model and general curiosity about a natural phenomenon. But the key-point to admire was his talent and initiative to act constructively to get quantitative answers to unanswered questions that were timely and important to him.

We are saddened by news of the deaths of two classmates. **Charles B. Pear, Jr.,** Course I, died October 26, 1989 at Melbourne, Fla. There were no details. **Gilbert E. Moos,** Course III, died April 16, 1989, at Freedonia, N.Y. Moos was awarded a BS from St. Lawrence University in 1936 and an SM (1937) and a PhD (1939) from MIT. His career included 12 years with American Oak Leather Co. and Celanese Corp. and 32 years with Rollins College and State University College at Freedonia, where he became emeritus professor of chemistry in 1983. He authored publications and books and held patents.—**Hal Seykota,** secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

40 50th Reunion

Following an earlier announcement, I have more information on the retirement of **Martin A. Abkowitz.** He writes, "I retired from my MIT professorship in the Ocean Engineering Department (formerly naval architecture, XIII) in July 1988 after 39 years on the faculty. During this time I enjoyed many sabbaticals, with a year in Denmark, a year in France, a semester in Singapore, a semester in Israel, a semester at the U.S. Naval Academy in Annapolis, and most recently, a semester travelling around the world, with a six-week lecture tour in China. The stays in Denmark, France, and Israel were associated with Fulbright Lectureship Awards. Presently, I am working about one-third time at MIT as a professor emeritus doing research of my own choosing on my own schedule and pace.

"I do have a schedule to meet—my tennis lessons and trombone lessons each week (haven't touched the trombone since the MIT-ROTC band). There are other benefits at reaching our age—free downhill skiing (no lift charges) and I take advantage of this. I am keeping active attending and presenting papers at professional society meetings and international conferences. My wife and I are looking forward to a great time at the 50th celebration."

A brief note from **Herbert W. Arnold** of Arlington, Mass., notes that he retired as a senior patent attorney from Raytheon in 1983. . . . **Charles F. DeMailly** writes from South Dartmouth, Mass., "After retiring as President-CEO of PCI Group, Inc. (sold out my majority ownership shared with classmate **Robert G. Miller** to a Fortune 500 company), and then retiring as chairman of RexCut Products, I am now engaged in digging out of problems at my real-estate development operations. It keeps a 1940 man running every day."

George B. Bradshaw, Jr., retired from DuPont in June 1980, and has been indulging in lots of golf, fishing, gardening, and community work. He lost his wife Frances in May 1986, and in October 1989 married Dr. Verne Peters, with whom he is now living in Destin, Fla. He is looking forward to the 50th.

Thomas Goldfrank of Mamaroneck, N.Y., has been reasonably active and content since his retirement six years ago, but unfortunately, he has negative feelings about his education at MIT.

After 45 years without any contact with the class, **R. Robert Snyder** of Harvey, La., sent a catch-up letter. He writes: "Much of my work was on construction, initial operation, and preliminary planning of hydro and steam electric power plants and related facilities in New Hampshire, Venezuela, Colombia, Ecuador, Turkey, Libya, and Pakistan. I lived abroad some 12 years. For several decades, I've pursued development of my idea of an energy source that uses no fuel and requires no nuclear reactions, falling water, sunshine, wind. There is ample proof that the so-called law of conservation of energy is invalid for certain non-thermodynamic processes. Energy is created in such instances. I need help and would like to correspond with people acquainted with electrets, photonic materials, optical fibers, and semiconductors. The object is to cause a flow of electrons alternately to and from one surface of a thin layer of a material that can be spirally rolled in cylindrical form, sandwiched between a foil and an insulator, if necessary. I can give no guarantee of success with my idea. But, if it works, it would reduce air pollution, the overheating of cooling water, the exhaustion of irreplaceable fossil fuels and the production of radioactive wastes. It may even be possible to have a solid-state electric power plant with no moving parts."

More information is now available on **H. Garrett Wright,** who passed away at his home in Springfield, Mo., last November 11 after a long illness. During his career, Garry had founded and served as president of several businesses, including the Garrett Construction Co., Tri-Lakes Concrete Co., Wright-Weeks, Inc., Wright and Associates, Inc., and the Garrett-Wright Lumber Co. In public service, he was a city councilman, an elder of his church, and past president of the Kiwanis Club. Professionally, he was a member of the Missouri Society of Professional Engineers and the National Society of Professional Engineers. Garry had been looking forward to seeing many of his old friends at the 50th reunion.

Mrs. **Mary B. Rahn** of Boston, Mass., died June 19, 1989. . . . **Stanley F. Luce** passed away on October 9, 1989. I have no further information on either of these classmates. We extend the sympathies of the class to all the families.

Albert W. Beucker and his wife Louise of Melbourne, Fla., recently returned from Cartago, Costo Rica, where he served as a volunteer with the International Executive Service Corps (IESC). After he retired as director of research and development from Beloit Manhattan, Inc., Al was recruited by IESC to assist Hulera Joyal (which does rubber recovering of various industrial rolls and drums) with improving sandblasting room operations, adjusting new recipes and recompounding, and organizing and building extruders.

The *Marlboro* (Mass.) *Enterprise* recently carried a story about **Herbert G. Weiss** of Lexington, concerning his memories of the wartime work of the MIT Radiation Lab. "It was go, go, go all the time," said Herb. There was instant feedback—ships were sunk all the time." Herb was drafted by the U.S. government and by MIT to help develop radar technology. While most of those drafted to work on the radar project were in their forties and fifties, Herb was one of the youngest in the group—just out of MIT. The British had been working on radar, but it was poor, with no resolution. The Germans had the technology to develop radar, but Hitler decided it was unnecessary, as his plans called for the defeat of the Allies in nine months. This serious miscalculation probably cost Germany the war. The Rad Lab worked seven days a week and late hours. Radar was tested in Boston Harbor; it was placed on roofs of MIT buildings, and other buildings that were taken over. It was radar that really built Route 128 and the New England electronics industry. Herb spent a year in England helping the Royal Air Force implement radar. The RAF worked with the Americans, who were flying bombing raids over Germany. The raids could not be flown during daylight, because of the superiority of the German fighter pilots. Using radar, the RAF helped set up "pathfinders"—the scientific leverage needed to fly at night. It was enormously effective. As one of the original engineers on the project, Herb was a member of the planning group that met last year to organize a 50th reunion. They collected old photographs and bibliographies, and managed to get WGBH to "tune in," with a production by *NOVA.*

Keep the contributions coming to the Reunion Gift Committee. We hope to see all of you in June for that great 50th reunion.—**Richard E. Gladstone,** secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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John Faxon Gilbert died September 12, 1989, at the Eagle Pond Nursing Home in Dennis, Cape Cod. Born November 27, 1917, he prepared at Watertown High School, studied naval architecture and marine engineering, and was a member of the Track Club, Catholic Club, Commuter Club, and the Propeller Club at MIT. He was employed as an engineer with the Dennison Manufacturing Co. of Framingham, Mass. He retired in 1982. After living in Ashland, Mass., John moved to Brewster, Cape Cod, in 1986. He is survived by his wife, Virginia Arsenault Gilbert, three sons, and two daughters.

Chester N. Hasert sent an article from *American Rowing* profiling our famous **Charlie Butt, Sr.** "A retired aeronautical engineer for the Department of the Navy, husband of 40 years and father of four daughters and a son, Charlie now spends most of his time advising and helping others in the rowing community. But his hours spent coaching continue to produce a record of success, unmatched by any other American coach, of which Charlie is very proud. His crews have won the U.S. Scholastic Championships 33 times and competed seven times in the Royal English Henley. He knows what makes a crew fast, excels in teaching correct rowing, and expects his boys to row hard and fast. From 1957 to 1967 his varsity crews won eight consecutive championships and his junior varsity won them all.

"Charlie is still impatient and testy in regard to training rules. The time he threw a varsity oarsman off the team for smoking and the times he put kids on planes from Europe early are well remembered. Why has Charlie done all this? It's probably because he is a humble guy who never lets his ego get in the way of accomplishing the



task at hand. He was the recipient of the 1981 John Carling Award to Rowing and the 1988 Jack Kelly Award. Charlie's answer for the 40 years of involvement is eloquently simple—I've gotten a lot out of it.'"

How many classmates are still skiing? Our class president **John Sexton** is headed for the slopes of Utah and Vail as I write this for a deadline.

Why don't you drop me a line about yourself and your athletic friends?—**Joseph E. Dietzgen,** secretary, Box 790, Cotuit, MA 02635

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Overcast and rainy in Clearwater this morning, and hence not golf weather—ergo a good day for Class Notes.

The Wellesley, Mass., *Townsman* reports that **Walter Woods** received the 1989 Community Service Award. His communal activities include 15 years on the local Board of Public Works plus service as vice-chairman of the Massachusetts Water Resource Advisory Board and chairman of the Citizen's Advisory Committee of the Massachusetts Environmental Protection Agency. . . . Retired Major General **Dick Gibson** is "having a ball" living in Surrey, Maine. He got rejuvenated by a heart bypass operation in December 1988. Still active in sailing circles, he navigated on the Marion-Bermuda race last June and sailed the Intercoastal Waterway last October. Ham operators note that his call sign is KB1TO. . . . **Art Graham** reminds us that he was an early member of the MIT Civilian Pilot Training Program, got his Aeronautical Engineering degree with our class and taught flying in 1942 and 1943. He worked for Douglas after World War II as an aerodynamicist and flew as test pilot on the DC-6.

One obit. **Phil Sheridan** died in Sarasota, Fla., in September. He had a long and outstanding career with General Electric and operated real estate holdings in Cambridge and in Boston. Phil's wife predeceased him. Our condolences to his children.

Thanks to all of you who took the time to complete Al Haye's "Alumni Questionnaire" and my "Class of 1942 Open Book Exam." Proves that your class archivist (Al) and your class secretary (me), while being good friends, do not overdo coordination! Am now almost embarrassed by the wealth of fodder I have for the Alumni Notes grist mill. It will all surface during the next few months.—**Ken Rosett,** secretary, 191 Albemarle Rd., White Plains, NY 10605

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Let us pause to remember two classmates who passed away in 1989. . . . **Warner B. Smith** (Course I) died October 24, in Lake Wales, Fla. Warner was born a New Englander in Malden, Mass. His ashes were returned to Mt. Auburn Cemetery, Cambridge. He is survived by his wife Erma. . . . **Robert W. Maxwell** (Course XIII) of Stuart, Fla., died November 2 in Tarrytown, N.Y. Bob was an international engineering executive who supervised the construction of large production facilities for many major corporations in the U.S. and overseas. He authored numerous technical articles and was honored by the governments of the Philippines and Brazil for his work. He was a Navy veteran of World War II and an avid yachtsman. He is survived by his wife Alice, three children, and two brothers. . . . We extend our condolences to the families of these men of '43.

The report about Bob Maxwell came from **Malcolm Walker** in Braintree, Mass. Malcolm and Bob were close friends in high school and at MIT, and kept in touch over the rest of their careers. Malcolm retired in 1983 from General Dynamics Shipbuilding. Since then, he has been associated with the Braintree Historical Society and the committee formed to celebrate the 350th year of Incorporation of the Town. Malcolm insists that in spite of what the Institute says, he is still a naval architect, and not an ocean engineer.

The October 16 *Wall Street Journal* reported that **Charles J. Lawson, Jr.** (Course XV) has a new position with National Micronetics, Inc., Kingston, N.Y. He was formerly acting CEO, and now holds the title of chairman.

Merton R. Hubbard, Hillsborough, Calif., has authored a book, *Statistical Quality Control in the Food Industry,* that will be published in April. He has also taken a one-year part-time teaching job for a local college. His subject: quality systems.

A colorful Christmas card from Marion and **Gilbert Monet** tells about their activities in Willow Street, Pa. Marion is a cello virtuoso, playing in ensembles and orchestras. She plans to take up the harp when she can get to it. Gil is struggling with piano and recorder lessons, with side ventures into sculpture and flower arrangement. Who would have thought that inside two chemical engineers lurked a couple of late-blooming artists?

And now, the next thrilling episode of "They Came to Albuquerque (Albq.)." Saturday morning we boarded a 5:30 bus bound for the Mass Balloon Ascension at the Hot Air Balloon Fiesta. We inched through incredible traffic—thousands of cars—and past what looked like a square mile of close-packed RVs, which had arrived the night before. It was said that over the course of a week, a half-million people would attend the fiesta. After an interminable ride, we pulled into a parking area, grateful that someone else was driving and that she had found a spot only a short distance from the midway.

"Midway" is the right word, because it was a quarter-mile path, 20 feet wide, lined on one side with food and souvenir concessions, on the other with balloons of every description. Between was a milling throng, flowing, swirling, surging back and forth. Over all floated music from an extremely robust audio system.

We arrived just as the first contingent of balloons went up amid cheers and fanfares. The passengers smiled and waved, as if they were really enjoying this foolhardy escapade. Thereafter, succeeding waves took off until 500 were airborne, filling the sky with fantastic shapes and colors. Albq. is blessed with a dependable air circulation that allows the balloons to float down the valley at one altitude, then descend to a lower level and return for a landing. At 10 o'clock the bus picked up the group and brought us back for a few hours of rest and sightseeing in Albq.

Later in the afternoon, we all met at the Tramway terminal at the foot of Sandia Peak, not far from the Ottinger hacienda. We loaded aboard the swaying cable car, the faint-hearted in the middle, and started the 10-15-minute ride up to the crest. Those who could overcome their acrophobia looked out the windows at the rocky walls going by and the valley spread out far below. At the top, we stepped briskly through a chilly breeze into the High Finance Restaurant, which apparently must receive all its supplies via the cable car. After a fine dinner and much sparkling conversation, we got back aboard the tram for the descent. In the darkness, the canyon depths were no longer visible, but we could see the myriad sparkling lights of Albq.

While you're waiting for the next installment, start thinking about your contribution to the 50th reunion gift.—**Bob Rorschach,** secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Weston Goodnow writes that he is a bona fide visitor of grandchildren, amateur patron of the arts, amateur investor, and amateur computer user. He engages also in other activities that retired engineers do. . . . **John Marmby** reports that he still is a principal technical advisor at the General Accounting Office giving advice to the Congress on military hardware. He mentions that **Stan LaValle** retired last year and recently toured the UK and France and flew back on the Concorde. Stan now lives in West Virginia near ski country.

We regret to report the passing of **Philip Whitaker** on November 29, 1989, retired professor of aeronautical engineering at MIT from 1959 to 1983. Philip was a member of the Guidance and Control Panel of the Advisory Group for Aerospace Research and Development of NATO from 1968 to 1977. He was also a trustee of the Citizenship Training program of the Boston Juvenile Court and former president of the Boston Junior Chamber of Commerce. He is survived by his wife, Jean, and three sons (Robert, Jonathan and Charles), a sister, two brothers, four grandchildren, and seven stepchildren.

A letter from Jeanne Dew, wife of **Robert J. Dew, Jr.** reports his passing on June 24, 1989. They both were looking forward to attending the 50th reunion. We extend our sympathy to the families of both of our departed classmates.

Ray Frodey is enjoying retirement by pursuing nature photography, nature writing, and becoming an environmental activist. . . . **Eugene Sard** retired in December 1988 from full-time work after 40 years at Airborne Instruments Laboratory now called AIL Systems Inc. . . . **William Sadler** and wife, Rowena, recently moved to Will Creek Landing near Williamsburg, Va. He feels this quiet village would make for a nice mini-reunion and volunteers to help coordinate arrangements. Everyone had such a good time at the mini-reunion we held there in the fall of 1985 that maybe we can repeat again in the near future.—co-secretaries: **Andrew Corry,** P.O. Box 310, W. Hyannisport, MA 02672; **Louis Demarkles,** 77 Circuit Dr., Hyannis, MA 02601

45 45th Reunion

'45s 45th Reunion is about 45 days away—June 7 through 10. Have you made plans to attend? If not, you still have time to be part of this gala affair. Contact your 45th Reunion committee, care of Alumni Association, or better still phone chairman **Charlie Hart** directly at (508) 653-4435.

We trust you caught the photo of **Jim Levitan** dressed in black tie in the fall 1989 issue of the *MIT Spectrum.* Jim was being recognized as a Sustaining Fellow, marking ten years of continuous support for the Institute. . . . Ellen and **Jim Brayton** plan to be off again to the Alps with the Fall River (Mass.) Ski Club. Jim points out that pretty soon we'll all be geezers. . . . Edna and **Budd (J.J.) Strnad** proudly announce the arrival of their first grandchild, Stephen, in September 1989. . . . In early December, **Pete Hickey** fell from a ladder while hanging a Christmas wreath—seven broken ribs and a punctured lung. Pete is recovering slowly and sorely.

A great photo from **Tom Stephenson** was taken while he and Jimmie enjoyed **Vince Butler's** hospitality in San Francisco. It was difficult to distinguish among Tom, Vince and the photogenic Rolls-Royce that they used as a back drop. . . . **George Bickford's** June 1989 marriage has entirely changed his outlook; rumor has it that "Curly" is now wearing a hairpiece. Can you imagine Bickford with a full head of hair? . . . Carol and **Nick Mumford** claim fame as '45's most prolific grandparents. While some of us have none, the Mum-

ILLUSTRATION: JOHANNA SCHWARTZ

fords are at 19 with 20 likely by the Reunion. Nick visited **John von Hemert** at his 150-year-old St. Peter's parish in Louisa, Va.

Suna and **Art Hall** spent this past summer sailing the Bay of Fundy and Nova Scotia; next year, the Florida Keys and Gulf of Mexico. . . . **Charlie Peterson,** our Reunion sports director, has been seen playing the New Seabury courses several times during the winter months in an effort to relieve all '45 golfers of excess funds come tournament time. . . . Although Libby and **Jerry Paterson** want to see old friends and classmates, Jerry fears Reunion may be impossible as the Patersons are planning a clan reunion at the Cape in late July. . . . **Max Ruehrmund** is so busy doing nothing in retirement that he and Trudy have not yet reached a Reunion decision. . . . **Buzzo Busby**'s son George (named for deceased classmate **George Hetrick**) continues in the oil business in Indonesia. . . . Billie and **Al Bowen**'s children are spread about; Andrea in Weld, Maine, Greg traveling the Pacific Basin from San Diego, and Laura in Hamilton, Mass.

Mary Trageser and **Mary Hoaglund** did an August 1989 Elderhostel to London, County Mayo, Ireland, and North Wales—18th century art and architecture, Irish history, Welsh literature, six plays in seven nights while in London plus one at the Abbey Theatre in Dublin. We certainly hope these two as well as other widows will be attending our reunion, because widows are a most important part of our class.

Fran and I will have caught Jean and Prexy **Chris Boland** at the end of their annual cross country ski vacation in mid February. I may, however, still be sailing with old Corinthian cronies down in the Bahamas. We could also report on Anne and **Bob Maglathlen**'s activities—however you can ask them directly at our 45th Reunion.

Think Reunion and we shall see you in Cambridge on Thursday, June 7.—**Clinton H. Springer,** secretary, P.O. Box 288, New Castle, NH 03854

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Looking back on the joys of last year and the heartwarming end of suppression in the Eastern Bloc, I must admit I wept when I saw people dancing on the Berlin Wall. Another joy was my rare attendance at a Colorado Alumni luncheon on December 27, to which they annually invite current and prospective students. A very simple affair, but a delight to see and listen to all these bright youngsters, who almost outnumbered the old grads.

There was a stack of Christmas cards and notes from our classmates: **Ken Davis** visited Steamboat Springs last winter. . . . Susan and **Stu Edgerly** played golf in Vermont last summer. . . . **Mario Vinci** lives in Laguna Beach. . . . We heard from **Russ Dostal.** . . . **Larry Body** works at Northrop and lives in Santa Ana, Calif., not too far from his 87-year-old mother in Anaheim. . . . **Stan Young** had a tough operation, but is okay now. . . . **Bob Nelson** wrote from Lompoc, Calif. . . . **Bill Cahill** has inimitable, amusing views on everything from my state of health to aspersion about a vaguely known paramour of mine, Claudine Longet.

The Alumni Office passed along a batch of short notes from classmates: **Dave Haug** is retiring from Draper Labs after 43 commendable years. . . . **John Bateman,** M.D., writes, "Good medical practice is based on sound engineering principles." . . . **Fred Ross** has moved from chief executive officer of RayMark, in Connecticut, to director of Newport Electronics in Newport Beach, Calif. . . . **Warren Turner** is busy in retirement, "especially with grandchildren," playing tennis, jogging, personal computing and spending three months (in the winter) in Juno Beach, Fla. . . . **Bob Neal,** a V-12 Course II escapee, lives in Arlington, Mass., owns JBF Scientific Co. in Winchester, and holds a patent on spilled oil recovery systems.—**Jim Ray,** secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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The *Technology Review* clipping service was really busy this month and sent us a good number of tidbits. Thanks, guys! Let's take them in alphabetical order.

Robert Creek died last September. He was a retired vice-president of UNOCAL and had lived in Inverness, Ill., for many years. He is survived by his wife Margaret and four children: Jeffrey, Robert Jr., Roberta Williams, and Cynthia Watson. Bob was one of those who chose to "make a difference" in the world. He ran for the Board of Education of the Palatine Township High School District 211 back in 1969—he was critical of local education and decided to do something about it. He won election, was made president of the board in 1970, and was re-elected each time since! In 1980, he was named Illinois School Board Member of the Year by the Illinois State Board of Education.

Theodore Davis retired from Martin-Marietta Aerospace in January 1989. He comments that he feels his 41 years in aerospace spanned some of the most fascinating years in its history. (I would think those 41 years were the *most* fascinating years in aerospace history!) Ted lives in Denver. We'll be moving to that area ourselves later in 1990—Highlands Ranch, Ted.

We know from a newspaper clipping that **Laurence Ford** ran for selectman in Redding, Conn., last November, but we don't know who won! He is administrator of Connecticut's Technical Colleges Fire Technology Programs and, among other things, serves on the Governor's Advisory Committee on Emergency Technical Services. It's obvious from his "platform"—and those of the other two candidates—that fire protection and policies and EMT services were "hot" issues in the election. Tell us who won, Bob, and we'll report in the column.

Peter Matthews retired from Draper Labs last July after 40 years of service. He worked there for the FAA. According to the last Alumni Register, Pete lives in Needham, Mass. . . . **L.C. (Roy) Oberholtzer** is manager of polymeric materials R&D for product design and process development in the Avionics Group—Rockwell International in Cedar Rapids, Iowa. Recently he was accepted for membership in "Plastics Pioneers"—a group honoring those who have at least 30 years in the plastics industry and who have made a significant contribution to the industry.

John Truxal is the author of a new book published by the MIT Press, entitled *The Age of Electronic Messages.* In it, he explores the capabilities and consequences of today's communication technology—from bar codes to medical images, from digital audio to signals through space. The book explains the basics of communications technology, including not only the scientific "nuts and bolts" but also the sociological factors surrounding the new technology. John is Distinguished Teaching Professor in the Department of Technology and Society at the State University of New York at Stony Brook. He lives in Dix Hills.

Lawrence J. Varnerin is professor of computer science and electrical engineering at Lehigh University in Bethlehem, Pa. He joined the University in 1986 as chairman of the department and was granted tenure in 1989. Prior to Lehigh, he was a researcher at Bell Labs for almost 30 years, specializing in magnetic phenomena and devices and materials. He is a fellow of both the American Physical Society and the Institute of Electrical and Electronic Engineers, and holds 12 patents for his work. He and his wife Marie live in Bethlehem and have eight children.

Finally, we have a *very* brief note from **John Bryant Williams, Jr.** About all that he tells us is that he lives in Rock Hill, S.C., and "thoroughly reads and enjoys each issue of *Technology Review.* (Perhaps because of the brilliantly written 1947 class notes?!)—**Robert E. McBride,** secretary, 1070 Pilgrim Parkway, Elm Grove, WI 53122

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Bill Weisz formally retired from Motorola at the end of 1989, but he will continue his association in a number of ways. He was chief executive officer until December 1987, and he will continue as vice-chairman of the board of directors. He will also be a consultant and Motorola representative on government advisory committees. He will teach regularly in management and training programs at the Motorola Training and Education Center. In 1981, Bill received the medal of honor from the board of governors of the Electronic Industries Association for his outstanding contributions to the advancement of the electronics industry. He has received several patents related to two-way radio communications.

Stan Abkowitz writes that his company is growing steadily, staying profitable, and he says he is having fun. Among his new employees are his son, Miles (WPI) after nine years at Textron, and his daughter, Susan, (Penn/Wharton) after six years at Nuclear Metals, Inc. Miles is director of contracts and finance, and Susan is director of engineering and quality. Stan writes, "With good engineering talent hard to come by, it pays to grow your own. Good long-range planning!" Stan and his wife, Lorraine, have one grandchild, Sarah, who was born in July 1989.

Stan's company, Dynamet, has developed processes and products based on using powder metallurgy. Dynamet reduces costs by using inexpensive tools and large amounts of raw materials. They also use blended elemental powders to replace the more expensive prealloyed powders. Recently, Dynamet has developed a proprietary process using cold and hot isotactic pressing (CHIP) to manufacture a new family of titanium macro- and microcomposite materials to near-net shape parts. In addition to patents on the process, Dynamet received patents on an improved titanium-based inlet and outlet valve for automotive engines. Stan said the valve stem consists of a lightweight microcomposite titanium alloy that has high stiffness and fatigue-resistance. The valve head contains a higher percentage of reinforcement than does the stem.

In December, our annual champagne brunch at MIT's Endicott House was attended by Joan and **Al Seville,** Virginia and **George Clifford,** Gloria and **Sonny Monosson, Graham Sterling,** Herbert Graetz, '45, Ginny and **Dave Finnegan,** Barbara and **Malcolm Reed,** Marge and **Bob Welch,** Jean and **Jack Juechter,** Tel and **Bob Sandman,** Eleanor and **Harold Ottobrini,** Dorothy Seltzer and **Allen Levenson,** Irene Kalfon and **Stan Shein,** Jean and **Milton Slade,** Nancy and **Don Noble,** Ann and **Ken Brock,** Anita and **Verity Smith,** and yours truly. Also attending from the class of 1949 were Fletcher and Mrs. Eaton, Mickey and Pam Ligor, Mrs. Harry Lamb, and Bob and Mary Cowan. Members of the class of 1947 and 1949 were invited as part of the plans we are making for a joint reunion in September 1991. In addition to discussions about reunion and other class activities, the people attending enjoyed sharing their experiences about travel, retirement or work, and family activities with one another.

Mike Kami has prepared two video tapes of a four-hour presentation on "Strategic Management for Times of Unpredictability." The goal of the presentation is to describe how to achieve effective, profitable actions in ten areas, including fast change, productivity, innovation, people, customers, etc. The tapes are designed to present to a group of 8-12 managers. Participants jot down new or different actions (and assign a priority). Then the group reviews the list and selects the five most important suggestions. Mike reports that many viewers have found these actions could be initiated right away.

Bill Russell retired from Draper Labs after 41 years of service. The retirement party coincided to the hour with the 20th anniversary of the Apollo 11 lunar landing. . . . **Lewis Blodgett** retired from the National Climatic Data Center as a

meteorologist in 1986. Lewis and his wife, Jane, still live in Asheville, N.C. They are active with the Carolina Mountain Club, a hiking organization, and do volunteer work maintaining parts of the Appalachian Trail and other trails. They are members of the Appalachinan Trail Conference. . . . **Bill Ihde** spent the summer building his retirement home. He and his wife are happy to be unpacked and are ready to see any classmates as visitors. They overlook the Tennessee River and are on the edge of the Smokies on I-40. Bill retired from his engineering company in June. He enjoyed working with his builder so much that he may have a second career in building homes.

Herb Kindler is director, Center for Management Effectiveness, a management development firm in Pacific Palisades, Calif. Since 1988, he has written Managing Disagreement Constructively, and Risk Taking: A Guide for Decision Makers. These were published by Crisp Publications in Los Altos, Calif. He and his wife, Marilyn, wrote Stress Training for Life. This was published by Nichols Publishing in New York. In 1958, Herb published Tenth Year Profile—Class of 1948. This was a major undertaking and had responses from 800 people receiving both undergraduate and graduate degrees. Herb was helped by **Jerry Krinsky, Len Salter, Ben Brettler** and **Dave Cist.** Other classmates served as reviewers. Also, typists had to decipher the handwriting of the respondees. **Norman Kreisman** made a voluntary contribution for the costs of printing and binding the book. Our class is fortunate to have the dedication of these members of Herb's committee. . . . **Harrison Rowe** is now professor of electrical engineering at Stevens Institute of Technology.

Harold Knapp died in November. After his retirement from the Defense Communications Agency last March, he was awarded the Defense Medal for Meritorious Civilian Service. Harold earned his doctorate at MIT. He served in the Army during World War II and worked for the Navy after graduation. He joined the Atomic Energy Commission in 1955. He wrote a report concluding that infants had been exposed to dangerous levels of radiation as a result of nuclear testing. It had been known that thousands of sheep died in Nevada and Utah in 1953 after an above-ground nuclear test. Harold reported that milk from cows eating contaminated matter also was a risk. He resigned from the commission in 1963 after his report was suppressed and joined the privately financed Institute for Defense Analysis. In 1981, he returned to government service.

As a private citizen, Harold undertook the cause of three black men accused of rape in rural Maryland. In 1961, after the men were convicted by an all-white jury and sentenced to death, Harold wrote a letter to a newspaper. As a result, he corresponded with one defendant. Harold began an investigation that lasted for several years, interviewing people connected with the case and uncovering new evidence. He collected affidavits challenging the story of the alleged victim. After 6,700 interested citizens signed petitions calling for a new trial, the governor commuted the sentences to life imprisonment. A second trial was called off after the victim refused to testify and prosecutors admitted to mistakes in handling the case. The defendants were freed. Harold is survived by his wife, Barbara, and three children. On behalf of our classmates, I extend our sympathy to his family.—**Marty Billett,** secretary and president, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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Back when you and I were young, the Fisher Body Coach Division of General Motors sponsored a nationwide contest in which young people tried to build a fiendishly difficult miniature Napoleonic coach. The model, when properly done, was a gorgeous 12 inches or so of intricate detail requiring enormous amounts of hand labor. Regional winners received four-year scholarships to the college of their choice. That was over 45 years ago; so why do I resurrect the subject now? It's just that, if memory serves, **Charlie Jordan,** GM's design chief, was a winner in that contest—no mean feat and a harbinger of Charlie's subsequent career that included his design of the classic 1959 Cadillac. Now, the October 2, 1989, issue of *Forbes* magazine, reports that Charlie's son, Mark, is the designer of what Forbes calls "the hottest car in America right now, Mazda Motor Corp's sporty MX-5 Miata convertible. . . . Buyers are lining up to get hold of his creation, offering to pay as much as double the car's $14,000 suggested retail price." Charlie's is a hard act to follow, but his son Mark is doing it.

Harry V. Madden, a retired computer systems analyst for the New England Electric System of Westborough, Mass., died of a heart attack at Faulkner Hospital in Jamaica Plain, Mass., on December 3, 1989. He was 65. Harry joined N.E. Electric immediately after his graduation from the Institute and remained for 33 years, retiring in 1982. During World War II, Harry served as a private first class in Europe, receiving the Bronze Star. In 1949, he was commissioned a second lieutenant in the Army Reserve and retired as a colonel in 1977. He leaves his wife of 40 years, Mary; a son, John, of New Castle, Dela., a daughter, Mary of Arlington, Texas; and two grandchildren.

Howard A. Reuter, a 35-year resident of Pasadena, Md., died of cancer at Johns Hopkins Hospital on September 23, 1989. He was 65. Howard was employed for 35 years as a senior engineer by the Westinghouse Electric Corp., Columbia, Md. His most recent work was in robotic systems for manufacturing, a field in which he had several patents. An avid painter, Howard attended the Maryland Institute of Art and the Schuler School of Fine Art. He also enjoyed music and Egyptian hieroglyphics. He is survived by his wife, Dolores, and three daughters: Rebecca Earnest of Alexandria, Va.; Jennifer Sanchez of Manassas, Va.; and Lynda Reuter of New Baltimore, Va.; and two grandchildren.

Charles B. Reimer, MD, of Decatur, Ga., died in New Orleans, La., on July 28, 1989, at age 67. At the time of his death, Dr. Reimer was a research biochemist and chief of the Immunological Branch of the Centers for Disease Control in Atlanta, Ga. Dr. Reimer had a long and distinguished career in the field of public health. He was the author of numerous articles in the current scientific literature concerning immunology, viral and bacterial diseases, vaccines, and immunodiagnostic reagent standardization. He was a fellow of the American Academy of Microbiology and a member or affiliate of many scientific societies including the American Association for the Advancement of Science (AAAS), American Association of Clinical Chemists, American Association of Immunologists, American Society for Microbiology, the Arthritis Foundation, and the American Rheumatism Association. He leaves his wife, Hester; a daughter, Christine; and three sons (Stephen, Mark, and Eric).

The class extends its sincere condolences to the families of all three men.—**Fletcher Eaton,** secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50 40th Reunion

This may be the last opportunity to remind you that the 40th Reunion of the Class of 1950 will be held at the Institute this June. By now many of your friends have registered for this one-in-a-lifetime celebration. Please let us hear from you soon. If you cannot attend please send us news about you or your family for these notes.

Herbert Benington is working on exploring new directions as director of planning for Unisys Defense Systems. . . . **Virginia (Stevens) Small** lives in Oak Harbor, Wash. She loves the Pacific Northwest and is married with four children. . . . **Ken Fertig** is on long-term disability from Draper Labs, following open-heart surgery and related difficulties. . . . **David Mackes** retired in 1989 from Westhinghouse after 38 years. He keeps busy with home maintenance, travel, and restoring a 1965 MGB. . . . **Edward Fox** is associate director of corporate packaging for Proctor and Gamble Co. in Cincinnati, Ohio. . . . **Lee S. Richardson** has retired from the University of Idaho School of Mines. He still spends some time in the laboratories and says that universities are more fun than industry.

David Webster, who works and lives in Nantucket, Mass., has bought a second home in Sarasota, Fla., for the winter season. . . . **Sebastian Gianni** retired in 1989 as vice-president and general manager of the industrial refrigeration division of Dunham-Bush. He and his wife reside in Wethersfield, Conn. . . . **Juan Navia** is acting dean in the School of Public Health at the University of Alabama at Birmingham. He is the grandfather of a 1-year-old boy. . . . **Nathan Cook,** who retired from MIT, now lives on Cape Cod in Eastham. He consults for Advanced Mechanical Technology, Inc., and "keeps a few brain cells active." He looks forward to seeing all at the June Reunion.

Joseph Oppenheim lives in Satellite Beach, Fla., and is taking courses at the Florida Institute of Technology. . . . **Marianno Romaguera** reports from Puerto Rico that he survived Hurricane Hugo in 1989 and looks forward to the reunion. . . . Ginny and **Daniel Flanders** plan to retire in beautiful Biloxi, Miss. . . . **Frank Ruccia,** who retired in 1986 after seven years with Monsanto, three years with Perkin-Elmer, and 26 years with A.D. Little, is currently involved with two-family businesses in Danbury, Conn. . . . **Donald Eberly** is the author of a book entitled "National Service, A Promise to Keep," which has received enthusiastic endorsement from such personalities as Fr. Hesburgh of Notre Dame and Senator Sam Nunn, Chairman of the Committee on Armed Forces. Don is director of alternative service at Selective Service in Washington, D.C.—**John T. McKenna,** secretary, 182 Midpine Rd., P.O. Box 376, Cummaquid, MA 02637-0376

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Responding to his own feelings that the best thing to export to underdeveloped countries should be a hands-on approach to business and education, **Edward Bronstien** will be spending time as a volunteer assisting a small furniture and mattress company in Guatamala City. This is being done under a program of the International Executive Service Corps. Ed writes that this trip is comparable to an executive version of a stint with the Peace Corps. He feels that he can improve their production, introduce labor saving (but not labor reducing methods), and enhance their safety program. He will be accompanied by his wife and will be there for about three months.

Word from **Frederick Ezekiel** is that he has become a director of Newport Electronics, Inc., of Newport Beach, Calif. Fred continues to be the president of Servoflo Corp., of Lexington, Mass. . . Continuing as the chief of contract administration of the Engineering Division of the city of Jacksonville Department of Public Works is **George E. Groves.** . . . After 37 years with the RCA Corp., **George E. Stevens** retired at the beginning of 1988. . . . Serving as the assistant secretary of the Air Force for Acquisition is **John J. Welch, Jr.**

We received the sad news of the passing of **David Hammel** on November 27, 1989. David had worked for GTE on the SAM-D and MX missiles. He also held a patent on a data processing system. He was a past president of the Lions Club in his hometown of Sherborn, Mass. We send our sympathies to his wife Barbara, to his two daughters (Lisa and Lori), and to others of his family.—**Martin N. Greenfield,** secretary, 25 Darrell Dr., Randolph, MA 02368

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I am assembling these notes on a rainy New Year's Day. The rain is a promising beginning after a year of drought. The perpetual drought of news has been relieved by several classmates who have kindly written. **Philip Thiel** says that he is still happily teaching and writing on visual design and "experiential notation." He also has developed several pedal-powered boats and looks forward to cruising the French canals in such a craft to draw and paint the scenery. He teaches at the University of Washington. . . . **Richard Silverman** says that his consulting practice continues to flourish since he moved back to the Boston area. He and his wife, Carol, currently live in Quincy, near their three children and three grandchildren. . . . And **Arthur Howard** writes that he lives in Sudbury and is president of Bemis Associates, a manufacturer of thermoplastic adhesives.

David Ulrich, of West Hartford, Conn., writes that he has retired from petroleum refining and is now teaching contract bridge at senior centers and in adult education programs. He has three children in college. . . . **Don Grine** announced his retirement from S-Cubed last December by saying, "My friends laughed when I sat down to play, but I'll show them I'm not as type A as they thought." I like his takeoff of the famous ad copy, and offer my own parody on retirement—"where every prospect pleases, and only my pension is vile." Anyone who has a better thought on retirement may submit his entry to the address below.—**Richard F. Lacey,** secretary, 2340 Cowper St., Palo Alto, CA 94301

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Please send news for this column to: **Gilbert D. Gardner,** secretary, 1200 Trinity Dr., Alexandria, VA 22314, (703) 461-0331

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A year ago, we reported that **Klaus Zwilsky** had been elected vice-president of ASM International, the 54,000-member advanced materials society, and that he would become president later in the year. It has happened: Klaus was installed as president at the society's annual meeting last October. Klaus continues in his position as staff director of the National Materials Advisory Board in Washington, D.C. . . . **Dave Dennen** sends word that he continues to serve as vice-president of Lilly Research Labs, Eli Lilly and Co., in Indianapolis. Dave is responsible for the "scale-up of human insulin and human growth hormone from R-DNA technology." . . . **Bob Evans,** Atran Professor of Labor Economics at Brandeis University, writes that he spent the 1988-89 academic year as a visiting professor in the Economic Observatory of Keio University in Tokyo, on a Fulbright Research Scholarship. . . . **Hank Hirsch,** professor of physiology at the University of Kentucky, informs us that he has started to learn to row a one-man shell. In his first childhood, he says, he did not have time to stick with crew.

Arnold Tubis has sent a note stating that he became head of the Department of Physics at Purdue University a year ago. He had been acting head of the department since the previous July. . . . **Jerry Cohen** continues as dean of the School of Engineering, recently renamed the McCormick School of Engineering, at Northwestern University. Jerry is a Sigma Xi national lecturer this year, and received the Barreff Award in Diffraction.

A letter from **Jim Hyde** informs us that he received an honorary doctorate of biology from the Jagiellonian University in Krakow, Poland, last September. Jim is professor of radiology, chairman of the biophysics graduate program and director of the National Biomedical Electron Spin Resonance Center, all at the Medical College of Wisconsin, in Milwaukee. He has written some 200 papers and holds 25 patents on techniques to probe complex biological systems at the cellular and molecular levels.

It is with deep regret that I report the deaths of two classmates. **Terry Palmer** died in early September. He lived in Waldorf, Md. . . . **Dick Hayes** died suddenly while on a business trip in Raleigh, N.C., in early November. Dick was president of Xerox Venture Capital in Stamford, Conn. He had been with Xerox since 1971. Earlier, he had been a test pilot for the U.S. Air Force, director of systems engineering for NASA during the Apollo Project days, and director of engineering at Polaroid Corp. He was a charter member of the Upper East Hayden Physics Society. Our sincere sympathy goes to Elsie Palmer and Ellin Hayes, and their families.—**Edwin G. Eigel, Jr.,** secretary, 33 Pepperbush Lane, Fairfield, CT 06430

55 35th Reunion

As you read this column, spring should be upon us and your final reservations should be made for the illustrious class of '55's 35th reunion! News about classmates continues to pour in.

Fred Lupton, at this writing, is on the official heart transplant list at Vanderbilt University Hospital, a beeper and a packed bag ready for a hasty exit to Nashville when the call comes. Fred and Jane ask that we keep them in our prayers and want us to know that they are extremely grateful for the miracles of 20th century medicine! Fred's recent honors, before his retirement in October, include being named Civitan of the Year by the Chattanooga Civitan Club. He was cited for his vision in helping everyone regardless of social stand.

Richard L. Forrester, formerly president of Stone & Webster Development Corp., has joined Alpha Associates, Wellesley Hills, Mass., as vice-president. Forrester will develop marketing strategies and plans for clients in service industries. Alpha Associates is a marketing consulting firm that primarily serves professional service firms. Previously, Dick was senior vice-president and director of U.S. marketing at Stone & Webster Engineering Corp. as well as president of the Development Corp. subsidiary. From 1980 to 1984, he was president and CEO of Stone & Webster Management Consultants. He joined the company as a mechanical engineer in 1957 after serving in the U.S. Army. Dick lives in Wellesley with his wife, Maureen.

The *Cape Codder* reports that Sherman Reed, an old navy captain, has worn many hats for the Town of Orleans on Cape Cod and recently stepped down as hard hat construction coordinator of the regional septage treatment plant facility under construction near Cape Cod Bay. In recent years, he volunteered on the Route 6 Task Force, the Charter Commission, the Bikeways Committee, and the Traffic Study Committee.

It is my sad duty to report this month on the passing of three of our classmates. **Judson S. Ball** from Evergreen, Colo., died in January 1989. . . . **Eugene R. Christine** of Rockville, Md., died January 17, 1989. We have no other details on these two passings. . . . We learned from Sally Hannom's response to the reunion questionnaire that **Thomas Barry Hannom** died in Scottsdale, Ariz., on January 10, 1989, after a career with Univac, Drexel University in Philadelphia for 29 years, and then Motorola. He had a heart transplant in 1981 and is survived by his wife, three children, and one grandchild.

The *Melrose Evening News* had a long article about **John Kennaday** who announced his intention to seek re-election to the Melrose School Committee. John lives with his wife, Eleanor, and has owned his own architectural construction estimating business in Melrose for the past 13 years. He has been a member of the Melrose School Committee for six years and has served on the finance, negotiations, and building planning subcommittees.

David Norton has retired after spending the last 29 years with Northrop Corp. Precision Products Division in Norwood, Mass. His final position was program manager of the development/production of the gyroscope used in the Inertial Measurement Unit (IMU) of the MX missile. He says he retired because there was not enough time left for all his personal interests.

Harlan Walker is still at home with chronic Epstein/Barr virus. He saw Burt Noyes (Wellesley) of the class of '54 recently with his wife and son, all doing well. . . . **Robert Dyak** reports that he is currently engaged in starting up the Virginia Center for Housing Research at VPI&SU. The center was give $150,000 by the Virginia central assembly last February. . . . **Joseph Champner** advises us that he had a marvelous time in Beijing, May 14-21, 1989, attending the 4th World Conference on Continuing Engineering Education. First-hand observation of events in Beijing have left a lasting impression with him and a love for the Chinese people. For the past four-and-a-half years, he's been teaching math and engineering courses at Covenant College at Lookout Mountain, Ga., and coordinating the dual-degree program with Georgia Tech.

I lost touch with **Norry Hersey** since our ROTC days together at Aberdeen Proving Ground (APG), Md. He plans to attend our 35th reunion and tells us that he moved to the Kansas City area last year from Atlanta. He is currently with U.S. Sprint as director of Customer Support Systems. Norry spends about half his time in Washington, D.C., but says it's a lot different there than it was when he was at APG in 1955 and 1957.

Edie and I look forward to seeing many of you in June at MIT, in Chatham at the Wequasset Inn and in Bermuda. In the meantime, keep the news coming.—Co-secretaries: **Robert P. Greene,** 100 Memorial Dr., Apartment No 11-2A, Cambridge, MA 02142; **DuWayne J. Peterson,** 201 E. 79th St., Apt. 11 I, New York, NY 10021

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Cosimo L. Cataldi retired as president of CYNWYD Corp. but is still an active member of the California State Bar. After being a workaholic since graduation, he now plays tournament duplicate bridge and travels. Cosimo resides in Rolling Hills, Calif. . . . **Maris T. Fravel** has completed 33 years with Bechtel, the last three in Taipei with a subsidiary, Pacific Engineers and Constructors, Ltd., engaged in power plant work for the Taiwan Power Co. and various local industries, as well as in Japan and the Philippines. Maris will be relocating to their office in Cairo, working with the Egyptian Electricity Authority. Home base is Bechtel in Norwalk, Calif. . . . **Russell L. Schweickart** is just completing a year as president of the Association of Space Explorers, USA; focusing on start-up business of NRS communications, mainly E-Mail systems linking U.S. and Soviet colleagues.

Reverdy E. Wright is still at the Army Material Command, serving on the National Advisory Committee of Association of the U.S. Army. Lydia and he enjoyed a visit to Hawaii last May to see their daughter Enid who is in the U.S. Navy. . . . We are saddened to hear of the death of **Bernhard W. Romberg** in an automobile accident last October. Our thoughts are with Margot (of New York City), their daughters Katherine and Linda, and family.—**George H. Brattin,** co-secretary, 39 Bartlet St., Andover, MA 01810, (508) 470-2730; **Irwin Gross,** Sweets McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

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Please send news for this column to: **John Christian,** secretary, 23 Fredana Rd., Waban, MA 02168



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Welcome to the nifty nineties! Things have been a little hectic here in "Mad city," as some folks call Madison. That plus a severe news drought has meant that this month's column is the kickoff for the decade.

Bob Parente has returned from England after a one-year stint. He was working on a project to privatize the electric supply industry in England and Wales—essentially a program to de-nationalize the industry, Bob says. . . . **Dan Brand** has been appointed chairman of the Transportation Research Board's Task Force on Advanced Vehicle and Highway Technologies. This is sometimes called the "smart highway" project. Dan says, "I am also continuing to run Charles River Associates' thriving consulting practice in transportation planning around the country." . . . **Richard Klafter** writes, "For the past five years I have been a professor of electrical engineering at Temple University. I am also director of graduate studies for the department. In March 89, my textbook was published, entitled 'Robotic Engineering: An Integrated Approach.' During my spare time, I am an active member of the Choral Arts Society of Philadelphia, a professional chorus."

We are saddened to learn of the death this past fall of **Roy Thorpe.** As many of you know, Roy was one of our class's earliest and more successful entrepreneurs. After building up a residential alarm company, Roy retired from active management in 1978 and moved to the Bahamas. He returned to the states several years later and managed a private railroad car charter service for executives and groups. As I recall, Roy came to one of our reunions via his first private railcar. We extend our sympathy to Roy's brother, Philip, and other family members.

By this time you've surely seen some of those lists of what's in and out for 1990. Did you know that writing to your class secretary is in? Let's get those cards and letters on the way, folks. Phone calls are okay, too. Just call (608) 244-1254 evenings or weekends.—**Mike Brose,** secretary, 841 Magdeline Dr., Madison, WI 53704

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Please send news for this column to: **Allan S. Bufferd,** secretary, Office of the Treasurer, MIT, 238 Main St., Suite 200, Cambridge, MA 02142

60 30th Reunion

By now you have all received Reunion Chairman **Jorge Rodriguez'** mailings on the schedule for our 30th reunion. I hope that many of you are planning to make all, or at least part, of the festivities. I am certain that we are really going to enjoy the fruits of the labors of Jorge and his committee.

I have not received much news this month; as I've said before, I cannot write these columns without your help, so please do write to me or include some information with your Alumni Fund contributions.

An article in the *Brunswick* (Maine) *Times Record* had a flattering article of **Harold Parmelee,** who was the speaker at a Bowdoin College business breakfast. Harold, who is president and CEO of Turner Construction Co., spoke on construction as a major player in the GNP, the challenges of current labor trends, and the Japanese impact on the building sector. . . . The *Wall Street Journal* noted that **Joseph Verderber** has been named president of the Specialty Products Unit of AM International, Inc., in Chicago. . . . Congratulations are in order for **Robert White** who was recently inducted into the National Academy of Engineering for this technical contributions in the area of magnetic engineering. . . . **Lawrence Kravitz** writes from Aberdeen, Md., that he is busy at Aberdeen Proving Ground testing tank survivability. Larry's wife, Yvette, is a swimming instructor at the community college and their two daughters are in high school. The Kravitz' are also busy visiting colleges for tours and interviews with daughter, Clara.—**Frank A. Tapparo,** secretary and class agent, 15 S. Montague St., Arlington, VA 22204

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Please send news for this column to: **Andrew Braun,** secretary, 464 Heath St., Chestnut Hill, MA 02167

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Received a nice letter from **Dave Koch,** who was surprised to see his name in the November/December column after class sleuth/treasurer **Tony Mack** saw his photograph in the July 17, 1989, issue of *Fortune.* Dave writes that the ID tag in the picture was a security badge provided by the Secret Service to be worn by White House visitors. He was visiting President Bush to discuss lower taxes and federal spending, free trade, sale of government assets, and an IRA alternative to the Social Security system. Dave and his brother Charles, '57, along with Jim Miller, former director of the Office of Management and Budget, and others formed an organization called Citizens for a Sound Economy about five years ago to promote the goals they discussed with the President. The organization has about 250,000 members and actively advocates free-market economic positions. Dave says the President gave the group a warm reception and seemed supportive of many of their positions. We also want to thank Dave for his challenge to all MIT alumni to match 50 percent of their increases in giving to the MIT Alumni Fund. We hope many of our classmates will respond to the Koch Challenge and increase their MIT contributions to levels over $100 during this next year.

Classmate **Oliver R. Smoot** has been elected to chair the Science and Technology section of the American Bar Association. Thinking of Ollie, classmate **Tom Burns** writes, "I found the first confirmation that the Smoot and the Ear have found acceptance in the bridge-building community across the nation. On a recent morning run in Los Angeles I found incontrovertible proof: on a bridge across the Ventura Freeway on Hill Street, I saw a clearly painted marking as follows: '135 + 0.5 Ear.' Obviously, since Californians are always in a hurry and the units are so well known, the word Smoots could be omitted from the notation." We are pleased to learn of the universality of acceptance of the Smoot as a standard of measure. However, I am not sure Ollie wants to be cast in some medium with low coefficients of expansion and contraction at the National Bureau of Standards, but then not everyone is as famous as Joule, Faraday, Ohm, Angstrom, and Oliver R. Smoot.

Erich P. Ippen received the first Harold E. Edgerton Award from the Society of Photo-optical Instrumentation Engineers for his work in ultrashort (picosecond and below) optical-pulse generation technologies. Erich is a professor in the MIT Department of Electrical Engineering and Computer Science, better known to us as Course VI. . . . **John A. Rollwagon,** chairman and chief executive officer of Cray Research, presented 20 awards to computational researchers who work on Cray machines at speeds of more than one billion calculations per second (one gigaflop). The fastest program ran at 1.708 gigaflops. Next year's awards will begin at the 1.5 gigaflops level. . . . **Warren McCandless** is vice-president, international, for Sealed Air Corp., with specific responsibilities for the Far East. Warren writes, "I have two wonderful daughters who both are attending their first college choices, Williams and Princeton, and a lovely wife who looks younger every day." . . . **John M. Cozzolino, Jr.,** has left the Insurance Services Office, where he served as research director, and is now a visiting associate professor of management science at Pace University, Manhattan campus.

Theodore C. Goldsmith wants to know if he can get MIT alumni auto license plates in Maryland. After checking with the Department of Motor Vehicles in Baltimore, I am told that for a fee Ted can get a custom tag with MIT on it, such as "MIT 1962," if one of our classmates has not already been assigned that designation in Maryland.

News of classmates seems to have reached an all-time high this issue. It was a real joy to hear from so many of you. Please keep those cards and letters coming in to: **Hank McCarl,** secretary, P.O. Box 352, Birmingham, AL 35201-0352

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As you may recall, there was no column in the February/March issue. I didn't get any news, so I submitted a column of what one might call alternative contents. However, the *Review* editors decided the material was inappropriate and did not print it. Call or write me with an item of class news, and I'll send you a photocopy.

This month we have no such problem. In late November, I got a great letter from **Mike Bertin.** Wrap your minds around this: Mike and Barbara spent from January to May 1989 on a round-the-world trip. They visited "friendly New Zealand, snorkeled on the Great Barrier Reef, and played with koala and kangaroos in Australia, stayed on the beach in Bali, watched Chinese New Year parades in Singapore and Kuala Lumpur and parasailed in Malaysia." They also rode on elephants in Thailand, beheld the Golden Triangle of Southeast Asia, climbed the Great Wall, biked in Beijing, and "saw the magnificent Taj Mahal at sunrise." They also sailed the Nile and "spent Passover in Israel (on a street in Jerusalem we met classmate **Alan Frey** and his wife)." Lastly, they "sampled the bazaars of Turkey, ferried to Greece, and watched the sun set over the caldera from a balcony on Santorini [before] walking about the ruins of the Angora. It was an incredible trip." More from Mike's letter next issue.

As you may know, **John Wawrzonek** is a pioneer in the photographic printing process called dye transfer. As capsulized in a review of his work in the *Memphis Appeal,* the process uses up to 12 black and white images before one applies any color. When one adds color, it is by primary color dyes, not light-sensitized paper. Thus, the processor retains complete control of contrast and saturation. Quoting the review, John "concentrates on landscapes . . . using a 4 by 5 format camera . . . [and] allows little foreground and almost no sky, completely filling the plane of the image from side to side and top to bottom. The detail and color . . . draw the viewer almost hypnotically." The revelation is that John has now opened a gallery in Worcester, Mass., to show the dye transfer process. He and his colleagues will also produce prints by John and by such masters as Eliot Porter, Joel Meyerowitz, and Irving Penn, plus black and white photos by Ansel Adams and Edward Weston. If you plan to be in Massachusetts, call John (508) 798-6612 for a sheet of driving instructions. It's a little tricky to get there

ILLUSTRATION: JOHANNA SCHWARTZ

(there is a "bug" in the road that connects Worcester with the Mass Pike), but apparently well worth the effort.

Finally, **Stephen Hester** reports he is now vice-president of marketing and sales for David Systems (he does not say what they do). He lives in the San Francisco area and loves it. His daughter Tara is a senior at UNC-Chapel Hill. You can write Stephen at 1016 E. El Camino Real, #212, Sunnyvale, CA 94087.

Please keep me out of trouble with my editor: write or phone with your news.—**Phil Marcus,** secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (301) 750-0184

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Happy spring! And it's about time. This morning (written in January) the thermometer read 27 degrees below zero Centigrade. That's cold, but not unexpected for Vermont. However, as it turns out, only yesterday Louise and I returned from a golfing and sightseeing trip to New Zealand and Australia. When we left Melbourne, the temperature was plus 27 degrees Centigrade. Oh well, what's a sign change among friends.

Speaking of change, **Pat Gage** has left Hoffman-LaRoche in New Jersey and is now senior vice-president of Scientific Affairs at Genetics Institute Inc. in Cambridge. Welcome back to New England and best wishes! . . . **John Goddard**'s daughter Christine is a member of the class of 1993 at the Institute. She aspires to a career in biochemistry. According to John, she has not yet been overwhelmed by the work, but he is a bit overwhelmed by the tuition—a mere $13,000 more per year than we paid as freshmen. . . . **John Huguenin** in another new MIT parent. His third, and last, child went off to Cambridge this past September. John is a full professor of engineering at the Massachusetts Maritime Academy and is living in Falmouth. His book *Design and Operating Guide for Aquaculture Seawater Systems* was published by Elsevier last year.

I hope that you were all generous with your end-of-year Alumni Fund contributions. More specifically, I hope that many of you sent along a news item or two with your contributions. The cupboard is bare!—**Joe Kasper,** secretary, RR2, Box 4, Norwich, VT 05055

65 25th Reunion

By the time this reaches you, I hope you've made your final plans to attend our 25th reunion on campus in June. In case *Technology Review* reaches you but the reunion mailings don't, the plan is for an on-campus reunion the weekend of June 8-10. The schedule for Institute-wide events should be written up elsewhere in this issue. I'm told we'll get "good seats" this year at Thursday's Tech Night at the Pops. Our class events start with a cruise on Boston Harbor Friday night. Saturday morning, there will be seminars on a theme of arts and technology at the Media Lab, introduced by our classmate Dean **Margaret MacVicar.** Then a class barbeque and picnic Saturday afternoon, and dinner that night at the Skyline Room of the Museum of Science.

With the 25th reunion comes the reunion class gift. Our class has a goal of $2 million (we've already raised more than $1 million!). The gift will be assigned to the Frederick G. Fassett, Jr., Fund for unrestricted purposes. I think the choice is especially appropriate in view of the close association our class had with Dean Fassett when we were at the Institute.

I've also received the usual few Alumni Fund envelopes and letters from classmates in the last month. . . . **Dick Schmalensee** writes that he's on leave from the Sloan School while serving as a member of the Council of Economic Advisors. Dick says he's enjoying working in the White House and his family's enjoying the Washington area. . . . **Dick Nathan** writes that he was re-elected a vice-president of Battelle and group vice-president and general manager of Battelle's Nuclear Systems Group based in Columbus, Ohio. Dick says his group recently opened an office at Technology Square in Cambridge to serve the Department of Transportation's Systems Center. Dick's daughter Wendy is a sophomore in the business school at Washington University in St.Louis, and son Daniel is a high-school sophomore.

Gene Chase sent a letter about his exploits since leaving MIT. He's professor of mathematics and computer science at Messiah College in Grantham, Pa., where he's been for 16 years. His special interest is natural-language processing, and that interest resulted in a year's leave of absence to work in Peru during 1987-1988. Gene has published two books on Christianity and mathematics—one a comprehensive bibliography (1983); the other, the proceedings of the seventh biennial conference on the topic (1989). Gene got a PhD from Cornell and also, better yet, found his wife there. Gene married Emily Parke 15 years ago in 1974, and they have three children, aged 12, 8, and 5. They celebrated their 15th anniversary last summer by visiting fellow alumnus Aureo Andino in Puerto Rico. Gene says he may not be able to make the reunion but appreciates hearing about you all in the column. Try to come to the reunion, Gene. We'd like to see you.

Fellow civil engineer **David Moran** writes that he's now director of the Taylor Institute at the David Taylor Research Center in Washington. Son Scott is MIT '90, Course XVI, and daughter Lindsay is Harvard, '91, majoring in English. . . . **Bill Pike** writes that he's still at Fidelity Management investing in junk bonds and related investments. The Pikes live in Wellesley and had their third child, Terren, last August. Their other children are Ben, 6, and Leo, 4. . . . A newspaper clipping advises us that **John Larkin** is the new minister at the Methodist churches in Richford and Montgomery, Vt. John and Carol have two children, Deborah, 12, and Ruth Mary, 9.

John Hershey has joined the G.E. Research and Development Center in Schenectady, N.Y., as an electrical engineer. John has a PhD in electrical engineering from Oklahoma State, and joined G.E. from BDM Corp. in Boulder, Colo. John and Anna have three sons and live near Charlton, N.Y.

So much for April. Two months to reunion when you read this. I'm looking forward to seeing you all on campus.—**Steve Lipner,** secretary, 6 Midland Rd., Wellesley, MA 02181

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Please send news for this column to: **Jeff Kenton,** secretary, 7 Hill Top Rd., Weston, MA 02193

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Your class secretary is very pleased to report that Ramtek Corp. has successfully emerged from Chapter 11 as a healthy, in-the-black, independent public company. I was appointed president and chief executive officer in March 1988 and can report that directing a turnaround and successfully taking a company through Chapter 11 requires an incredible amount of dedicated and smart work by the right team of employees. My pride in our Ramtek team, approximately 120 employees, is unlimited. Morale is very high, and we look forward to the challenges and opportunities of the 1990s! We are headquartered in San Jose, Calif., and we design, manufacture, and market high-performance, high-resolution imaging and graphics display systems and peripherals.

John Rudy, our energetic class agent, manages Raytheon's CAD/CAM software organization and also keeps busy with skiing, bridge, and racquetball, in addition to his many activities on behalf of our class and MIT. John's wife, Janice, is a speech pathologist with most of her spare time devoted to barbershop singing. Their son Brett, age 16, wants a Porsche and is not at all sympathetic to the fact that his father was 21 before he had his first car. Hilary, age 13, is involved in theater.

I am sorry to report the death of **Gardiner Gay** on July 17, 1989. Gardiner died unexpectedly in Montreal while visiting the city to attend a friend's wedding. He leaves his mother, Joanlik Gay, of Northboro, Mass., and his brother, Robert Gay, of Seattle, Wash. Gardiner was a consulting engineer at the time of his death. . . . **Bill Ewing** has been named the winner of the Air Force Rome Air Development Center's (RADC) Harry Davis Memorial Award for outstanding achievement in signal processing technology in support of Air Force programs. The objective of the award-winning work is to develop state-of-the-art infrared imaging systems using high-resolution infrared-sensitive focal planes based on RADC-developed detector technology. Bill has been on the center's technical staff since 1973. He and his wife, Elisabeth, and their son, William, live in Stow, Mass.

George Nybakken writes that he is living on a lake in Connecticut and working as a marketing specialist for Uniroyal Chemical. His son is a senior at the Art School in Syracuse, and his daughter will be studying theater there next year. . . . **Andrew Skibo** recently sold part of his consulting group to Life Sciences, Inc., a subsidiary of Day and Zimmermann of Philadelphia, which provides engineering and construction management services to the pharmaceutical and biopharmaceutical industries. As part of the transition, Andrew has assumed the position of executive vice-president, managing western region operations.—**Jim Swanson,** secretary, 878 Hoffman Terr., Los Altos, CA 94024

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We haven't had many weddings to report recently, so we are pleased to start off this month with the news of one. **David Coomber** was married to Munira Kazma in June 1989. They traveled to Hawaii, which Dave described as "a really beautiful spot to visit." . . . From nearby Baltimore, **Robert Phair** writes that he is still at Johns Hopkins School of Medicine but now is associate professor of biomedical engineering and of physiology. He's working on the role of cytosolic calcium in atherogenesis and in vascular smooth cell biology. . . . **Fredda (Hoffman) Cole** has a new position as executive vice-president of International BYAD, Inc., Schaumberg, Ill.

From a lot farther away, we hear that **Michael Rabinowitz** is spending a year as a visiting associate professor at the National Taiwan University in public health, studying pollution and children's classroom performance. His spouse, Diane Hoxmeier, is able to expand her repertoire of Chinese martial arts. "Taipei is colorful and dynamic, a boom city. The food variety and quality is excellent, and the people are friendly, kind, and antinomian. Come see for yourself!"

We hear that **James Roberto** has been elected first vice-president and president-elect of the Materials Research Society. He has been at Oak Ridge since 1974 and is now associate director of the Solid State Division. Jane and James live in Farrugut, Tenn., with their children, Andrew and Timothy. . . . That's all for this month; look forward to hearing from you.—**Gail** and **Mike Marcus,** co-secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

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To begin with a little musical interlude: According to *The Enterprise* (a Falmouth, Mass., newspaper), "When jazz pianist **Edward K. Scheer** performs before an audience, he looks around the room to see who is tapping his feet. 'If one person is enjoying it, it'll start to spread.' " Edward has been

BY DAVID P. HAMILTON, '89

Bridging the Gap Between Science and Education

Last year the University of Arizona in Tucson introduced a joint program between its schools of education and science to foster careers in science education and better prepare science teachers of the future. Their choice to direct the program is Richard Greenberg, '68, an internationally known planetary dynamicist and a member of the imaging team for the Galileo space probe. University officials believe that Greenberg is the first senior research scientist in the country who has been appointed to a full-time education college position.

"My job is to coordinate all sorts of science education that is aimed at the pre-college level," Greenberg said in a telephone interview. The task of teaching science teachers has been "dropped at both sides, both the science side and the education side of the university," he continued. "This is a problem faced by most large, research-oriented institutions."

Improving the situation requires reform on several fronts, Greenberg said. Simply improving intercollege communication, for instance, might ease considerably the administrative headache of advising science education majors. Under the UA system, science education majors must transfer their registration to the School of Science after their second year, but few science advisors are sufficiently familiar with the dual program to guide students smoothly through the process. Greenberg intends to seed the science departments with advisors who have been steeped in the program's bureaucratic intricacies.

Course requirements for science education students are also "very unrealistic," Greenberg said; students not only do extensive coursework in the science department, but must take at least 30 units of education classes. When Greenberg added up the courseload for a typical student in biology education, he found that the student needed nearly 170 units to graduate, compared with the university average of 125 units. Physics and chemistry education are not quite as demanding, but are "still bad."

Scientific education typically emphasizes the research track at the expense of alternatives because of the money and professional standing associated with research, Greenberg said. In his opinion, that fact has potentially dangerous implications for the nation's supply of science teachers. "As a result, we see students at the end of their sophomore year, looking at these unit requirements, and finding that they need an extra year for a bachelor's degree that gets them into a profession in which they're overworked, underpaid, and often not treated professionally. Not many make that choice."



Richard Greenberg, '68

"Public education is in its eleventh hour. I think we can turn it around . . . we have to."

To address the problem, at least in part, Greenberg is looking at curriculum reform that would help reduce the load for science education students at UA. State-required education courses, for example, might be substituted for a few of the general arts and science requirements. At the same time, certain science requirements would be shifted toward "pedagogical" courses that would emphasize the practical aspects of science—such as a class on how to run a chemistry laboratory.

On other fronts, the university is pressing ahead with programs that bring teachers into the university for introductions to "cutting edge" research and technology. The chemistry department, for instance, runs a National Science Foundation program in which science teachers learn to use advanced laboratory equipment. The astronomy department offers a master's degree for teachers. And a new experimental program presents modern image-processing techniques to teachers. "It brings up a lot of cognitive and information-processing issues," Greenberg said. "You'd be surprised at the amount of processing you can do on a PC-based system."

Not surprisingly, Greenberg is excited about his new post. "Public education is in its eleventh hour," he argued. "I think we can turn it around, and we have to, or we will have lost the American educational system." But improved teacher training can't solve all the problems in the schools, Greenberg said, particularly when already overburdened teachers are asked to take on problems well outside the educational sphere. School desegregation, for instance, is "a laudable goal, but teachers can't teach and solve society's problems at the same time without the resources for the job."

Greenberg's work has increased his awareness of how important it is to train science teachers in top-quality institutions, and reflection has left him a bit critical of his alma mater. "It would be wonderful if MIT had an education department. That would certainly help to prepare future science teachers." □

a research associate at the Woods Hole Oceanographic Institution since 1973 studying underwater acoustics. Ed joined his first band at age 14, took eight years of accordion lessons but never took piano, minored in music at MIT, played for five years at the Copley Plaza Hotel (1981-86), and now plays at various inns on the Cape. . . . **Matthew M. Franckiewicz** was recently named to the American Arbitration Association's national panel of commercial arbitrators. Matthew does labor arbitration and practices law in the Pittsburgh, Pa., area. . . . **Roy W. Haley** is now president, CEO, and director of American General Finance, Inc. (a subsidiary of American General Corp.) in Evansville, Ind.

Lance E. Hansche is now executive vice-president of Phoenix Technologies Ltd. of Norwood, Mass. Formerly, he was the company's president and CEO. . . . Professor **Steven M. Maser** of Willamette University has been named as a recipient of the Burlington Northern Foundation Faculty Achievement Award for 1989, in recognition of his outstanding academic and professional achievements. Steven is professor of public management and public policy in the Atkinson Graduate School of Management. . . . That's all the notes filling the hopper. Let's have some mail!—**Euegene F. Mallove,** secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

70 20th Reunion

Timothy Gilmore and his spouse, Susan, are expecting their third child. . . . **Dan Kidd** is running a small machine design firm in the Maine woods west of Portland. . . . **David McComb** has left Arthur D. Little in Cambridge after eight years and has started his own consulting firm in Dearborn, Mich. His primary interest is in improving management processes, and he believes the automotive industry will provide him many opportunities. Although he liked ADL, he finds being on his own marvelous. . . . **O. David Asbell, Jr.** took some time to install a microwave test range and use a telescope in the southern Arizona desert on a project for Georgia Tech. He also went scuba diving with the sea lions off of Santa Barbara and backpacked around Mineral King in the Sierra Nevadas. . . . **R. Steven Mullinax** is working for Intel as a software engineer and continues to be active in triathlon competition and folk music.—**Robert Vegeler,** secretary, Beers, Mallers, Bachs, Salin & Larmore, 1100 Ft. Wayne Natl. Bank Bldg., Ft. Wayne, IN 46802

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Please send news for this column to: **R. Hal Moorman,** secretary, P.O. Box 1808, Brenham, TX 77833

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Hi! I'm glad to report a fair amount of news for this month. **Lawrence Klein** continues to concentrate on his internal medicine private practice in Washington, D.C., but he also regularly drives up to Johns Hopkins Medical School to continue his research interests in clinical geriatrics, focusing on the medication problems. . . . **Terrill Chang** has been named vice president for special projects at SCS Engineers. They are capitalizing on the current public interest in (fear of ?) solid and hazardous wastes.

Kevin Trangle recently started a company called Business Health Management. They consult and provide services in occupational medicine, including environmental risk assessment, clinical medicine, and worker's compensation. Kevin recently built a new clinic and, with a partner, started an environmental testing lab. He became the director of Occupational Medicine at Mount Sinai Medical Center and has a doctor's handwriting or lack thereof. Kevin would appreciate hearing from old friends, colleagues, and prior Kappa Sigma members. . . . In other New York City medical news, **Phyllis Fishman Lantos** has been appointed vice president of financial services at Montefiore Medical Center.

Paul Hochfeld reports, "The older I get, the happier I am to say 'no news or major life changes,'" Sound familiar? He saw **Ken Stone, Dan Nadler, Arthur Kilmurray** and Neil Cobelli, '73, last summer in Maine. Paul is still a full-time Emergency Room physician raising (supporting) sheep "who aren't so dumb when it comes to food and sex." He also plays golf whenever possible, about once a week and in early November holed out from 140 yards for an eagle on the 18th hole. Not bad!

The mail also brought news that **Daniel Nadler** recently published a book as a co-editor, entitled *Glare Disability and Contrast Sensitivity for Clinicians.* . . . After 11 years of work at Systems Control, Inc., and Systems Control Technology, Inc., in Palo Alto, **Steven Shladover** last summer moved back to the academic world. He is now the technical director of the Program on Advanced Technology for the Highway (PATH) in the Institute of Transportation Studies at University of California, Berkeley. They are researching the next generation of road transportation technology. . . . **William Brotherton** is an anesthesiologist at Hackensack Medical Center in New Jersey. He and his wife Nancy have two sons, Michael, 6, and Brian, 3. Finally he is finding time to golf, ski, and play tennis and bridge.

I regret to announce that **Gary Solomon** died on July 10, 1989.

That's it for this month's news. I am obviously back from my latest jaunt overseas, having returned for the fall and winter. **Dick Fletcher** and I want you to send more notes to either of us. I write this just after the new year, and I hope that this decade will be a great one for you.—**Wendy Elaine Erb,** co-secretary, 6001 Pelican Bay Blvd., Apt. 1003, Naples, FL 33963

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We've got a few bits and pieces to pass along and a letter I'll save for later. **Gregory Moore** attended the ESG seminars this past spring, and had fun there. Professionally, he is building a new committee in the business law section of the American Bar Association and practicing law full time. . . **Ann McBain Ezzell** is back at school again, majoring in sign language at Madonna College, in Livonia, Mich. "Worse culture shock than the Peace Corps," she moans. "Where are the problem sets?"

David Reed and Jessica had little girl, Katie, last year, in the midst of the turmoil of building 1-2-3 Release 3.0. While that was going on, Colin designed and built an exoskeletal arm position sensor for his science fair. . . . **Alan Spoon** has been named president of Newsweek, Inc., a *Washington Post* subsidiary, after being vice president and CFO for the parent company. Prior to that, Alan had served as vice president for new business development and planning, controller and marketing/finance vice president.

Karl Gallegos treats young adults with substance abuse problems and directs addiction research at Talbott Recovery Systems in Atlanta. . . . **Tom Lydon** writes of missing the annual golf tournament he competes in with fellow Theta Chis **Bill Billing, Dennis Intravia,** and **Wes Grandmont,** but having won in 1987 and 1988, he "let them eat their hearts out." Mary and **Tom Paula** and offspring Mary Elizabeth, Tommy, Eddie, and Maura are all fine and looking forward to commencement in June. Of what, you ask? Tom is back at the Tute, being sponsored by Raytheon (partially) in the management of technology class of 1990. This program leads to an MS and is a joint operation between the engineering and management schools.

Nothing new on the home front, except that Eric gets his driver's license today, so God help all teenage womankind. Write!—**Robert M.O. Sutton, Sr.,** secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115



Class of 1975 invites fellow alumni/ae from the classes of 1971-1979 to join us at our Gala Night at the Children's Museum. This special evening will include food, drink, dancing, and casino. If you are interested, please contact the Alumni Association, (617) 253-8230.

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Twenty years ago this month you were probably thinking about the senior prom. Let's see what you're thinking about this year. **Steven Glazer** is thinking about getting married. He and his bride-to-be are planning a June wedding. Steve's an attorney for Wyman Beutzer Kuchel & Silbert, an LA-based law firm. . . . **Elizabeth Wise** is thinking about Sierra Dawn Wise Young, her 8-month-old daughter. . . . **Bruce Schobel** is thinking about Africa, from which he returned in November. Bruce has been to Africa nine times. Last year he conducted 30 seminars in the U.S. on Social Security and Medicare. . . . **Judy Fallows** is probably thinking about Zachary Gropper Fallows, her new little one. Judy writes that Zachary "is happy eating Trix in the grocery store before dinner."

Richard Hartman was selected Teacher of the Year by residents at Washington University in ob/gyn. He's building a new home for the wife and four kids. . . . **Jeffrey Weinreb** is currently associate professor and director of magnetic resonance at New York University Medical Center.

Two long letters came around the holidays from classmates. **Kenneth Miller** wrote to tell me about his doings in the past year. In 1988 he ran for state representative in Ohio. He lost but did get a chance to visit the White House, shake hands with Ronald Reagan, and thank him for serving the country. In 1989, Ken ran for city council in his home city of Mansfield. His well-thought-out campaign was not endorsed by the local paper, and he lost to incumbants. Since the end of the year, things have been rocky for Ken. He has been hospitalized by the Ohio courts against his will in the psychiatric ward of Mansfield General Hospital. His appeal for release was denied and his continued confinement was ordered as being in his best interest. Friends interested in Ken's continued well being can write to him at 565 Braeburn, Mansfield, OH 44907.

The other letter ends this column on an upbeat note. I received a nice, handwritten (!) letter from **David Alexander** around the end of November. David writes to tell us that he's living in Bellerose, N.Y. He has his own computer consulting company, Opal Computing, and it keeps him very busy, as does his wife and year-old son "(in a good way!)."

Plant your peas. Raise your roses. Happy spring.—**Lionel Goulet,** secretary, 115 Albemarle Rd., Waltham, MA 02154-8133, (617) 899-9694

75 15th Reunion

Hooray! We have a healthy column this month! . . . **Brian Berkeley** is presently working at Apple



Class of 1980 invites fellow alumni/ae from the classes of 1976-1984 to join us at our Gala Night at the Children's Museum. This special evening will include food, drink, dancing, and casino. If you are interested, please contact the Alumni Association, (617) 253-8230.

Computer as manager of Analog Engineering. He was part of the original Macintosh design team and started the original Macintosh II program with two other engineers. . . . **Joel Voelz** writes, "Well, we survived the earthquake just fine; from the network news coverage, people assumed San Francisco had disappeared. I am still with Autodesk, but for the last year I have been working with some of our acquisitions on their business and marketing activities. Right now I am director of marketing for our subsidiary, Xanadu, which is developing the ultimate Hypermedia server product." (Now you have us all dying of curiosity!). . . . I had a nice note from **Richard McCarthy.** He returned from his three-year residency in Jeddah, Saudi Arabia, in December 1988. He is still with Arthur D. Little, Inc., after 12 years in the energy area. In February 1989, Rich and his wife had their second daughter, Kathleen Margaret. Rich is having a great time playing with her and her 4-year-old sister, Lauren.

Edward W. Capparelli and his wife Gillian (Middlebury, '75) have spent the last six years as medical missionaries directing a medical program working with the Miskito Indians in far eastern Honduras, Central America. They have three children: Elizabeth, 7, Daniel, 4, and Robert, 2. . . . **Robert P. Weinberg** writes, "My wife and I just bought a home in Littleton, Mass. We have been married three years now. I am happily practicing medicine both in Boston and Lowell, specializing in internal medicine and family practice. My wife, Linda Stein, is an environmental consultant, also a vegetarian, pacifist, buddhist and budding photographer." . . . **Leonard Jay Weiss** will be graduating from the psychiatric residency program at Michael Reese Hospital in Chicago in June 1990.

From the legal corner, **Gerald Fabiano** became a partner at the law firm of Morrison, Mahoney & Miller in Boston. . . . **Michael S. Cucchissi** writes, "The law firm I helped form two and a half years ago (Pettis, Tester, Druse & Krinsky) has grown from 17 to 36 lawyers. We have been successful so far and have a bright future as one of southern California's best firms. I have been busy refereeing AYSO soccer games (Tom Stagliano would be proud of me). Barbara has been designing our new home, which is under construction in San Juan Capistrano. It is a Georgian colonial type home—very unusual for this area. It is on a hill overlooking rolling hills and Mission San Juan Capistrano." (You are in for visitors, now!). . . . From a GZA news release, I learned that **James D. Okun,** the corporation-wide manager of Environmental Health Services of Goldberg-Zoino & Associates, Inc., has relocated from the Newton, Mass. headquarters of GZA to the Vernon, Conn. office. Jim is responsible for business development in the areas of indoor air quality, industrial hygiene, and risk assessment, as well as management of projects in these technical areas. Jim is a member of the Society of Risk Analysis and the Society of Environmental Toxicology and Chemistry.

George Tremblay is presently managing Benjamin Thompson & Associates, Inc.'s, work on Park-in-the-Valley, a 23-acre mixed-use development in Mission Valley, San Diego, featuring 800,000 square feet of retail and office uses, as well as a 300-room hotel. He was formerly with Perry Dean Rogers & Partners and has served as a project architect on a wealth of educational and health-care facilities, including the Wellesley College Science Center, Killian Recital Hall at MIT, the Boston University Stone Science Center, and Metpath Laboratories in Boston. . . . And finally, an odd and partially illegible message from **Nicholas Vasilatos:** "Pulse and respiration remain nominal; well into long gray years—still lots of chi?ro-sc?ro." You will have to write again to decipher the last two words.

That's all for now. Keep writing.—**Jennifer Gordon,** secretary, Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036

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Please send news for this column to: **Arthur J. Carp,** secretary, Stalco Futures, Inc., 254 West 35th St., 16th Floor, New York, NY 10001, (212) 736-1960, Fax: (212) 736-3664

77

I am writing this column on the first day of the 1990s; how quickly time flies! I hope you and your loved ones enjoy a healthy and happy decade. . . . **William Sweet** returned to the states last June after 30 months in Wuerzburg, Germany. He is now a major (U.S. Army?) attending staff school at Fort Leavenworth. He expects to move again this June. . . . **Cynthia Koelker** is "taking it easy for a while" in Akron, Ohio, where she is working part-time as an urgent care physician. She finished three years of public health in Kentucky, and she is contemplating writing a book. Her third child, Katrina Marie DeFord, was born last May. Cynthia plans to return to family practice soon. . . . **Philip Belanger** is proud to announce the birth of his first child, Bernard Philip, class of 2011.

Steven F. Caplan has been promoted to senior vice-president at AM International, Inc, in Chicago. He continues as chief strategic office there and as president of AM Ventures. . . . **Stephen R. Blatt** and his wife, Faith, are now living in Manchester, N.H., with their son, Zachary, who is almost 2. Stephen works for Sanders Associates, and he keeps in touch with another former Bakerite, **Charlie Briggs,** who lives with his wife, Alice, and two children in Lyndoboro, N.H. . . . **Christopher Barnett** reports that "the big event of the year was the birth of my son, Nicholas John, on May 7, 1989. He is a healthy, happy baby and reminds Elizabeth and me of his older brother, Alex, at that age. We are delighted with both boys. I will be beginning my third year at the Massachusetts Water Resources Authority in December (1989), working on what is loosely known as the Boston Harbor clean up. The past two years have been challenging and enormously interesting, and I'm pleased by our progress with the project." . . . **Christophe Berg** is now working at Waters Chromotography, just five minutes from his home in Holliston, Mass. His wife, Christine, is working as a scientist at Brown University. Their son, Matthew, is now almost 3 and a bright, athletic, talkative little boy.

Over the Thanksgiving holiday, I ran into **Adrian Alcala** at Union Station in D.C. He was still sporting that distinctive ponytail. He was down from western Massachusetts visiting his brother here in Washington. I remain busy with family centered activities. We are especially enjoying watching Brielle grow from a baby into a toddler. She is learning English, and a little American Sign Language, too. Please take a few moments to inform us all of your whereabouts and/or whatabouts. Write to **Ninamarie Maragioglio,** secretary, 8459 Yellow Leaf Ct., Springfield, VA 22153-2522, E-mail to hertz@ccf3.nrl.navy.mil (internet)

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It is my sad duty to report that **Mark de Lemos** died of cancer in September 1989. While at MIT, Mark lived in Burton and participated in Dramashop and the Math Club. He had been working in software development on the West Coast. We send our condolences to his family.

With classmates' continued support of the Alumni Fund come notes sent along with donations: **Jeff Rubenstein** writes, "I divide my time among building cellular telephone systems (in Montana and Nebraska), the electronics service business, the beeper business, and even helping with the manure-spreading, home on the horse farm in Erieville, N.Y." . . . **Bob Ledoux** was promoted to associate professor of physics at MIT. Bob lives in Bedford, Mass. . . . Margot Loraine Berger was born in July 1989 to Janice and **Scott Berger,** who are "still smiling." The Bergers live in Horsham, Pa. . . . **Janet (McCleary) Schaab** writes, "I have spent the last five years at Texas Instruments in Sherman, Texas as an electrical and manufacturing engineer. My husband, David, is a software engineer at E-Systems in Greenville. We are expecting our second child in March, at which time I'll leave the work force for a while to devote time to Derek (6), his sibling, and the garden."

Stephen Zale writes from Uxbridge, Mass., "My new wife, Rebecca, gave birth to a daughter, Renee Kathryn Zale, in May 1989. Becky is a toxicologist at ENSR Consulting and Engineering, and I am a biochemical engineer at Sepracor, a startup separations company in Marlboro, Mass. . . . **Janos Pasztor** writes, "I left the United Nations Environment Programme in May, and moved to Boston with my family in June. I am now working on energy and environment analysis at the Boston Center of the Stockholm Environment Institute, hosted by the Boston-based Energy Systems Research Group. It is interesting to be back in Boston after a decade." Janos and family live in Newton Highlands, Mass. . . . **David Edelman** sends us news of a pending major move: "I am leaving my job as assistant professor of statistics at Columbia to take up a tenured lectureship at the University of Sydney as of July. My wife and I have managed to get permanent residence visas for Australia, and the plan is to settle there permanently." . . . **Thomas D.Y. Chung** writes, "I'm now a postdoctoral fellow at Merck Sharp & Dohme Research Labs in West Point, Pa., in the Department of Virus and Cell Biology, where I'm working with the common cold virus. I still haven't gotten my first cold from it." Tom and wife Barbara live in Norristown, Pa. . . . **Drahomir "Mike" Lazar** writes, "I am still in the Navy, redesignated an aerospace engineering duty officer in May 1989 and promoted to lieutenant commander in July. My wife Martha ("Brucie") and I moved in August to Brucie's home town, Virginia Beach, Va. I'm stationed at the Naval Aviation Depot in Norfolk. As a project officer, I manage depot-level repair/remanufacture of the A-6E Intruder and F-14A/A+ Tomcat and will be flying test flights on both aircraft. Brucie is a computer programmer for Computer Dynamics. We just moved into our new home and are busy decorating and getting a yard in."

Shahla and **Nayyar Butt** moved to Tucson for Nayyar's temporary assignment with IBM. Bayyar says he loves the west, but misses New York City. . . . Fellow Arizonians Laura and **Neal Rockowitz** moved to Phoenix, where Neal joined a private orthopedic practice. Neal reports that Cali Nicole Rockowitz was born in October 1989. . . . Good news from **Rich Brudnick:** "I got married this October in Boston to Cynthia Elliott (U. Vermont '79, Annenberg School of Communications '81). Best man was **Jiri Nechleba;** guests in attendance included Marla and Alan Levin, '76, Bernice and Jack Mandelbaum, '76, Peggy and **Harold Ka-**

mins, Alice and **Rich Bradford,** and Rich Smiley, '77, and wife Barbara Thornton, '77. Good friends at MIT remain good friends for life!"

Phil Kesten reports the successful completion of the Class of 1978 Care Package Project, through which parents of MIT undergrads had care packages delivered by Class of 1978 elves to their exhausted offspring just prior to finals week. The approximately 370 students who received packages appreciated the treats and enjoyed the chance to meet and talk with "crusty old alumni from long ago." Elves who helped in the effort included **Cindy Hussmann Berman, Paul Malchodi, Frank Murphy, Frances Scovil** and **John Slater.** In addition to the goodwill, the project netted about $2400 for our class treasury and the Class of 1978 Student Aid Fund.

Class president **Milton Roye** passed along news of some Boston-area classmates after making some calls for the Class of 1978 Care Package Project: **John Begg** vacationed in Europe at the end of 1989. John works for a venture capital firm in downtown Boston specializing in small to mid-size companies. . . . **Peter Cheimets** is "still building telescopes for the Smithsonian." . . . **Cindy Chen** has a new baby, MacKenzie Andrew, born in August. . . . **Bob Maresca** has been with Bose for three years, and has a daughter, Cara, born in October. . . . **Joan Olsen** is at Boston Edison doing research on energy projects. She is active in the Boston Church of Christ which has grown from 30 to 4000 members. Joan says many MIT and Harvard students belong to this congregation. . . . **Bill Fejes** and wife now have two daughters, ages 2 years and 7 months. . . . **John Slater** left MIT about two years ago and now works on development and marketing of expert systems at Stone & Webster, with major clients in the chemical industry and in civil engineering. John and his wife have a 2 1/2-year-old daughter and are expecting another child. . . . **Martin Lurie** is still with IBM. Martin and wife Ann have a baby girl, Margo Rebecca, who is about five months old.

From local press clippings, we receive news that **John Veneziano** is the new public works director for the city of Fairfax, Va. John has been with the city of Fairfax since 1984 and prior to his new position was the city engineer in charge of capital improvements. John lives in Vienna, Va. . . . **Peter Jansson** was promoted to regional customer service director, ocean region, at Atlantic Electric Co. Peter lives in Tuckerton, N.J. . . . **Bob Asher** writes, "This summer my wife Linda and I took our first trip to Europe. We spent three weeks traveling through Switzerland, Germany, and the Netherlands. This included one fabulous week in Amsterdam, where we attended the conference of the AIPPI, an international association of patent lawyers. When we returned, we began our quest to sell our house and buy a new one. I can now happily report that this gruesome task was successfully completed." Bob and Linda live in Needham, Mass. . . . **Maureen (Montgomery) Blake** tells us that she and her family relocated to Marlton, N.J., in the Philadelphia area. She and her husband work for Nielsen Marketing Research. Maureen says she manages to juggle job and family because she has an *au pair*—an international exchange student who exchanges babysitting for the opportunity to experience America. Maureen highly recommends the program, called the Experiment in International Living, through which she found her *au pair.*

Your class secretary and wife **Diane Curtis** are enjoying the friendly Columbus natives, the courteous drivers (except for what appears to be an occasional Boston transplant to keep the roads lively), and the convenience of suburban living. At the same time, we have begun the search for a farm. It turns out that almost all farms in Ohio have oil and gas leases assigned to them, and that pumps and storage tanks come with most farms. It's interesting to see that these domestic pumps are dormant now when prices are low. Might tariffs on foreign oil reduce our trade balance, and at the same time reduce consumption, and possibly eliminate the need to exploit ecologically sensitive areas? Let's hear from classmates/economists/geologists!—**Jim Bidigare,** secretary, 2470 Billingsley Rd., Columbus, OH 43235, (614) 889-1817; **Julie K. Ozaczka Stahlhut,** assistant secretary, internet:jstahlhu@hstbme.mit.edu,Compuserve: 76566,1012

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I am writing this on New Year's Day, and I offer a sincere wish to all classmates and their families for a bright and wonderful decade, complete with the fulfillment of all of their fondest hopes and wishes.

Now, let's see, who's been doing what? **Glen Langston** is a scientist at the National Radio Astronomy Observatory in Charlottesville, Va. . . . **Lee Weinstein** is a senior staff fellow in endocrinology at the National Institute of Diabetes, Digestive, and Kidney Disease. . . . **Jim Hasse** is still with DuPont in Houston and is the father of James Michael born last August 17. . . . **Gail Kaiser** was promoted to associate professor of computer science at Columbia effective January 1. "Only 2-1/2 more years without sleep until my tenure decision in spring 1992!"

John Arenivar had the following to offer: "In the ten years since graduating from MIT, I have earned a PhD in chemistry at Berkeley, did a postdoc at University of Alberta in Edmonton, then moved to Cincinnati. Here I joined a local chemical company, had a daughter (now 3-1/2), bought a house, had a son last March. Have managed not to start a business or go bankrupt (yet!). Still much in love with Becky (Frame, Wellesley, '80)." . . . **Dan Jaffe** writes, "I am a professor at the University of Alaska teaching analytical and environmental chemistry and doing research on pollution in the Arctic. This past summer, I traveled on the Arctic coast, backpacked in the Brooks Range, caught lots of salmon, and got chased by grizzlies!"

Mark Chan writes, "After working as a lecturer at California State University, Fullerton for three years, now I am at BP Research Center in Sunbury, England, near London. I am doing research in the stimulation of oil flow into oil wells using explosives." . . . **Andrew Weiner** has been promoted to the position of district manager at Bellcore (a.k.a. Bell Communications Research). His group performs long-term research on high-speed laser systems and optical information processing systems. Andrew and his wife Brenda live in Eatontown, N.J. . . . **Chuck Keilers** recently left Arlington, Va., and the Naval Nuclear Propulsion Program, where he had been working on radiation shield design. He is now enjoying California while working on a new PhD in aero/astro at Stanford University.

That's all for now. Please note my new address.—**Sharon Lowenheim,** secretary, 98-30 67 Avenue, Apt. 6E, Forest Hills, NY 11374

80 10th Reunion

Please send news for this column to: **Kate Mulroney,** secretary, 118 Riverview Ave., Washington Crossing, PA 18977

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Hello everybody! in the past few days, I have received an envelope from MIT as well as several cards and letters . . . just in time for another deadline!

Nora Fong writes describing her recent trip to Africa. She says that the excursion included a week-long rafting trip and a lot of trekking. She had a fabulous time in the wild, including a few narrow escapes from hippos, elephants, and other dangerous animals. Nora is currently working in California.

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Class of 1985 invites fellow alumni/ae from the classes of 1981-1989 to join us at our Gala Night at the Children's Museum. This special evening will include food, drink, dancing, and casino. If you are interested, please contact the Alumni Association, (617) 253-8230.

Erik Mueller writes that he has been promoted to vice-president in the analytic trading unit at Morgan Stanley in New York City. He is involved in the research, development, and operation of a computer system for trading in financial markets. Erik's book *Daydreaming in Humans and Machines,* which models the human stream of thought, is available in bookstores. MIT also sent me a press release about the book which is "geared toward those interested in using computers to augment human creativity and/or interested in exploring how the mind works."

Kevin Pykkonen writes that he received his MBA from the Wharton School in May 1989 and is working for the management consulting firm of Booz, Allen and Hamilton. His most recent assignment was in Mexico City where he brushed up on his rusty Spanish skills. . . . **Elliott Berger** is living in Sandown, N.H., where he has started a new position as principal engineer at Analytx Electronic Systems in Hudson. Analytx is a recent acquisition of Sanders, which is a recent acquisition of Lockheed. The company designs and builds electronics for space vehicles. Elliott says that reliability and radiation requirements make the job very challenging.

Abby Shevitz, MD, is the chief medical resident at Boston City Hospital. She is very involved in AIDS clinical and research work. . . . **Peter Haig** is a partner in the Architectural Design Corp in Orleans, Mass. . . . **Christian Svendgaard** is assistand vice-president with North American Reinsurance Corporation in New York City. He recently received the distinction of fellow of the Casualty Actuarial Society. . . . **Andrew Myers,** assistant professor of chemistry at Caltech, and **Cumrun Vafa,** assistant professor of physics at Caltech received Packard Foundation Fellowships.

That's it for now. Please send your cards and letters. Also, if anyone would like to write a guest column, please let me know. As for me, it's another beautiful January Sunday in Boca Raton. It's time to return to the tennis court.—**Lynn Radlauer Lubell,** secretary, 2380 Northwest 41st St., Boca Raton, FL 33431

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Please send news for this column to: **Linda Schaffir,** east coast correspondent, 50 Aiken St., #512, Norwalk, CT 06851; **Michelle Gabriel,** west coast correspondent, 656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 44086; **Stephanie Pollack,** secretary, 135 Sutherland Rd., Brighton, MA 02146

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Those of you in California will be happy to know that it is a few days before Christmas and the Boston area has had frigid temperatures since Thanksgiving. Fortunately our classmates have some baby news to warm us up. . . . **Randy Schweickart** and Michelle Heng, '84, announced the birth of Marielle Claire November 14. The odds makers offer 9 to 2 that Marielle has blonde hair, and is every bit as cute as her older sister Ashley. . . . **Jeannie Spurlock** and her husband Federico Genoese-Zerbi, '86, also report that they are happily adjusting to parenthood. Their daughter Allessandra was born December 30, 1988. . . . And a rumor out of the New York suburbs is that Rosemary and **Steven DeFalco** have also just had their second child. More details as they become available.

In the "On the Way" department, **Don Clayton** writes that he and his wife Melanie are expecting their first child in March. Don is the director of Purchasing Operations for Ingram Book Co., the nation's largest trade-book wholesaler.

Several classmates have recently taken on new challenges. . . . **Matthew BenDaniel** has been named product manager for InterSystems. Matthew will be responsible for InterSystems' relational database and application generators for DOS and XENIX platforms. . . . **Jeff Stevens** left Leo Daly in Omaha to take a new position as structural engineer for the City of Lincoln, Nebr., Department of Buildings and Safety. . . . **William Merrill** completed a PhD in chemical engineering at the University of Minnesota and is now senior research chemical engineer at the Film Technology Center of the 3M Company. . . . **Brian Jacobs** has completed an MBA at Stanford and is now working for Security Pacific Ventures in Orange County. . . . **Mike Santullo** has been promoted at Raynet, a subsidiary of Raychem, working in the telecommunications industry.

In other class news, **Doug Sargent** recently married Dawn Webber. . . . Mina and **Pete Fader** report good news in that they are moving into a brand new house shortly. Pete says the bad news is that the house is still in Philadelphia. . . . As for me, I'm off to Australia and New Zealand with Rich Kosowsky, '82, before returning for the home stretch of B-School.

Keep those cards and letters coming (and do your best to write something funny)!—**Jonathan Goldstein,** secretary, 2 Soldiers Field Park, #201, Boston, MA 02163

84

Lots of news this month. First from the mail bag. . . . **Bruce Kinzinger** graduated from the University of Kentucky Med School this past May. He is now working as a post-doc fellow in clinical decision analysis. . . . **Hauke Kite-Powell** started in an ocean engineering PhD program in the fall and is doing research at the Marine Policy Center at Woods Hole, Mass. He is also organizing bicycling events, competing in triathalons, and raising a wolf. . . . **Lesa Aylward** had her first child, Thomas Ross, in August. Congratulations, Lesa.

Mark Skinner writes (a real letter, stamp and all) from Hawaii. He is in the Physics Department at the University of Wisconsin but is on Maui trying to do Gamma Ray astronomy using a telescope on top of the dormant Haleakala volcano. He figures data collection will take about a year (all together now, awwww!). Work is keeping Mark busy but Maui is keeping him playing: beaches, scuba diving, snorkeling, and biking *up* Haleakala (10,000 feet, and Maui starts at sea level).

Over to the e-mail: our class vice-president **Michael Battat** works for Teradyne in California and is playing basketball twice a week. Mike recently attended the wedding of **Jeffrey Friedman** and Jennifer Letterman in Philadelphia. Also attending were **Erik Borne** and wife Margaret, **Mark Miles,** and **Eric Jaeger. . . . Ken Zeger** completed a master's in math and is finishing up a PhD in electrical engineering at the University of California Santa Barbara. He will be pursuing tenure in the Electrical Engineering Department at the University of Hawaii starting this summer. What's going on with Hawaii? The class of '84 must know something.

My answering machine happily reported the birth of healthy, 8-pound Alyssa to **Gil** and **Linna Ettinger. . . . Mark** and **Shelle Ensio** have had their second daughter, Kylli. Congratulations to the happy parents.

Now turning to the "Infamous New Year's List." The sixth annual convocation of the New Year's World Tour was held in Bedford, Mass., in conjunction with the wedding of Lieutenant **Dennis Sacha** and Denise Neirinckx, '87. The wedding was beautiful, with a reception at the Hanscom Airforce Base NCO club. Despite the hideous weather, a great time was had by all. The wedding poured over the next day to a New Year's party at Kelly, '86, and **Chris Craven**'s house. Over 50 people were there, T-shirts were made for the occasion, and by about 4 AM the party finally wound down. Attendees included all of the following: **Jeff** and **Ann Berner,** who are expecting their first bambino in May. They both work for Boeing in Seattle and will be spending six months in Tokyo soon after the birth of their child. Jeff is still playing lacrosse. This summer they climbed Mt. Rainier—14,410 feet. . . . **Dave Walter,** who is buying a house in the Seattle area, still works for Boeing.

Larry McKenna and his wife Liz had a baby girl, Elise. Larry is working at home watching Elise learn that the two things in front of her eyes are her hands. . . . Bruce Paulson, '86, was also among the revelers. He bought a house this summer near Mt. Sunapee. . . . Since I am next on the list, I am expecting a PhD this June (no house or child yet), and Lori, '85, is still working for Prime. We celebrated our six-month anniversary recently. . . . **Paul Bradford** is a freelance consultant. His first job was a two-month vacation driving around the U.S. Dan O, '85, should have his doctorate (doctor of rock) by next year. He is still dee-jaying, learned to surf, is working in a paying band, and has been dating Bonnie for over two years. . . . Lee Fortunato, '86, is in grad school at University of California San Diego in molecular biology. She is also surfing (excuse, surfin).

Neil Savasta is still working hard at Oracle. He refuses to learn how to play bridge. . . . **Leif LaWhite** is living in a house/garage he built in Vermont. He is doing electronics consulting. Vermont is pretty quiet, so visitors are always welcome. . . . Bob Sugar, '85, has also become a homeowner in Boulder, Colo. He is now working at Bernoulli Optical Systems. . . . Jay Anastas, '85, is still working at SatCon, trying to get funding for a racing effort, restoring a Bug, and lusting after a Miata.. . . Michele Kimpel, '87, is working to clean up the environmental messes that we engineers make. She plans on going into writing soon. . . . **Jeff Yoon** bought a condo in Fremont, Calif., and moved in two days before the earthquake (no damage). He is still working for Consilium and doing some traveling.

Vivian Wang is an architect, living in New York and loving it. She will be designing additions to Leif's house. . . . Roy Glikin, '884, owns a new Cambridge condo. House and owner are doing fine, and are looking forward to the 1990s. . . . **Brett Hilderbrand** and previously anonymous POSSLQ Jane Bedner are living in New York with some new furniture. . . . **Eric Alani** will have defended his PhD in February and is probably now Dr. Bonzo. Eric will be post-docing in the Boston area, hanging tough. His girlfriend Esther says that our New Year's party dashed her images of the classic, calculator-toting MITer. . . . Norman Burtness, '85, is designing jet engines for Pratt and Whitney in Connecticut. He is teaching junior-high Sunday school and may pursue teaching more seriously someday.

Our partyy hosts Chris and Kelly were surprised that so many people could fit into the house and dance in the living room without dropping into the basement. Chris is working on flexible ceramic superconductors and is still a rugby husband. Kelly is a soccer wife and together they are a skiing couple. Kelly has a great new

job right behind the Necco factory and is finally convinced that the factory is not Willy Wonka's place. . . . Peter Lee, '83, is back at MIT trying to finish an SB after goofing off in California. . . . Ailish O'Connor, 'W85, will be a JD (juris doctor) by this time next year. She sums up the party in fine Santa Cruzian as "dudical hairy," with lots of dancing between the wedding and New Year's. Ailish will be working in Miami this summer and probably for a while after that. . . . Finally, **Dave Brock** and his wife Jennifer were seen popping in at the New Year's party.

It has been an overwhelming start to the New Year. People traveled over 80,000 total round-trip miles to attend our sixth festival. I've been sitting here typing the news for over two hours (and I would be glad to do it everytime if there was enough news). . . . On a personal note, to all my friends and fellow revelers, I love you all and hope we will be doing this for many years to come. That is all for now. Think sun. From Boston.—**Howard Reubenstein,** secretary, 38 Belknap St., Somerville, MA 02144, (617) 625-9299, hbr@ai.mit.edu.

85 5th Reunion

John Ragan expects to graduate in July or August with a PhD in organic chemistry from Harvard. Then he'll head to UC/Berkeley for a two-year postdoctoral appointment. The group he is working with recently completed their project on the total synthesis of FK506, a promising new immunosuppresive agent that was written up in the *New York Times* and *Boston Globe.*

Catherine Gehrig is continuing to work on her PhD in chemistry at the University of Arizona. She is happy to announce her engagement to Arturo Chavez-Pirson, '83. . . . Eric and **Kathy Balles** are proud parents of a bouncing baby boy as of last November. . . . **George Fan** worked at Microsoft last summer as a product marketing intern on printer drivers for OS/2-related software. He is now at the Anderson Graduate School of Management at UCLA with **Adrian Wang.**

Adrian says orientation hadn't even ended before companies started showing up on campus for brown bag lunches, receptions, etc. Since he is planning on concentrating in marketing, he went to all of the brand marketing firms such as Kraft, Pepsi, Carnation, Clorox, etc. They're much more fun than going to consulting firms or investment banking firms: dynamic people, videos of brand commercials, and free food. It's a great way to augment the ol' student budget! Between classes and company functions, they have club meetings for career nights, Days-On-The-Job, etc. Fortunately, they cap off their four-day week with the traditional Thursday night beer bust (six kegs and munchies for about 300 thirsty MBAs). He thought he'd have lots of time to catch up on his studying given a three-day weekend, but unfortunately he goes to sailing class down in Marina Del Rey every Friday afternoon.—**Stephanie Winner,** secretary, 1026 Live Oak Dr., Santa Clara, CA 95051, internet:winner@apple.com

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I was pleasantly surprised to hear that **Jim Wilkerson** tied the knot: he married Heidi Geldaker, of Blytheville, Ark., where Jim is stationed as a pilot in the Air Force. They were married in Oregon on June 24, 1989, and they honeymooned in Jamaica. . . . **Stephen Robbins** attends Harvard Business School and is "looking for a direction in life." . . . **Scott Berkenblit** has finished two years of medical school in the HST program and is currently finishing up his master's in Course VI. Scott plays in the MIT Concert Band and other musical groups.

Carolyn Beer sent me a Christmas card from Illinois, where she is working on her Ph.D. at the University of Illinois. . . . **Rich Maurer** came out to Los Angeles to visit, and he made a training flight to Norton AFB and hooked up with **Karl Tucker.** Both of these ex-AFROTC guys are serving their time with me in the Air Force. . . . **Brian Miller** and **Chris Dacunha** are at Stanford Business School. . . . I hear that **Tom Paterson** is at Carnegie-Mellon for an advanced degree. . . . **Joe Bush** is here in El Segundo, Calif., working for Hughes along with **Mark Caylor. . . . Sonya (Sakai) Vogtmann** thoroughly enjoyed her first year of marriage. During the year, Sonya took up running and beach volleyball.

Mary (Cox) Engebreth was married on November 11, 1989 (Veteran's Day, no pun intended) to Erik Engebreth (a Stanford grad). Three of the ushers were Stanford men and three of the bridesmaids were MIT women **(Karen Wohl, Anne Fricker** and **Ellen Epstein). Mark "Bismarck" Emineth** flew out from Washington, D.C. **Ray Schmidt** came from New York, and **Karl Tucker** came from San Bernadino to attend this gala affair. Erik and Mary spent the next ten days basking in the Cancun sunshine and scuba diving in Cozumel.—**Mary C. Engebreth,** secretary, 1800 Hermosa Ave., #A, Hermosa Beach, CA 90254

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Please send news for this column to: **Stephanie Levin,** secretary, 41 Prentiss St., Cambridge, MA 02140, (617) LIP-NOSE or (617) 547-6673

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I guess the holiday season has kept everybody busy, since I haven't heard from too many of you recently. . . . Thanks to **Ted Larkin** who updates us on a few of the Burton Third Bombers. . . . Ted is a marketing representative for the New York Central branch office of IBM. He enjoys living and working in Manhattan very much and keeps in contact with **Minor Huffman III.** Minor works in the Wall Street area as a senior consultant for Quotient, a financial services company. . . . **Sean Banchik** is at the Cambridge Technology Group, near MIT. He is now the manager of new business development. . . . **David Huntley** is a major part of a light industrial startup in his hometown of Athens, Ohio. His firm builds and markets recumbent bicycles. All of them are looking forward to the Bombers 21st annual reunion this April at MIT.

Navy Ensign **Burl Amsbury** recently completed his first solo flight in the T-34C training aircraft while serving with Training Squadron-27 at the Naval Air Station in Corpus Christi, Tex. He joined the Navy in March 1989. . . . **Lisa Martin** is attending NYU Business School. . . . **Anita Pellman** became Mrs. Gross, and is living in Silver Springs, Md. Congratulations!

Bob Bielinski threw a holiday bash, to which over 50 guests attended. Among those were **Mikey Teng** and Mike Howard, '86. . . . I met up with a very tan **Young Shin** at the Knicks vs. Atlanta game at Madison Square Garden in January. He's doing better now that he's working regular hours (as opposed to the graveyard shift). . . . That's it for now. I hope to hear from more of you in the near future!—**Grace Ma,** secretary, 435 E. 30th St., New York, NY 10016, (212) 689-8780

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Barry Margulies writes from Baltimore that he lives on pizza and snacks during late nights in his lab at Johns Hopkins. He's been in a few classes with **Suephy Chen** and **Gigi Hamad,** but is not in the medical program as they are. Barry is in a "killer Ph.D. program called 'Biochemistry, Cellular and Molecular Biology.'" . . . Barry also writes that **Alice Loh** lives in Brighton and works at the Genetics Institute in Cambridge, and that **Christina Park** works at Biogen in Cambridge, as does **Paul Han.** . . . **John Harrington** and **George Roscoe** are 2nd lieutenants in the U.S. Marine Corps, and have graduated from the Basic School in Quantico, Va. Both reported to Communications Officers school following their graduation and room together until they complete their training. Following that, John will report to the 3rd Marine Division in Okinawa, a small prefecture of Japan. George will report to Camp Pendleton in California.

Ruth Schreibman works at Charles River Associates in Boston as a consultant. . . . **Sharon Belville** works as a technical writer for the Project Athena Documentation Group. . . . **Theodore Bloomstein** finished his VI-A last June and was named a Rockwell International fellow. He is back at MIT for his Ph.D. . . . Also named a Rockwell fellow and back at MIT is **Paul Beckmann.** . . . **Isako Hoshino** is pursuing a PhD in the MIT Materials Science Department. Also in the department are **Livia Racz, Scott Deering, Josephine Cheung, Shiao-Ming Chu, Elliot Schwartz, Michele Sequeira,** and **Julia Putnam.** Isako says that **Matt Machlis** now drives an RX-7 and is working on his master's in aero-astro. . . . **Andrew Tompkins** is at Carnegie-Mellon, working on his PH.D. in computer science. He also drives an RX-7 (Isako thinks Matt had some influence there). . . . **Vince Chau** is at the University of Chicago, grinding through medical school. . . . **Howard Zolla** is at Harvard. . . . **Ann Jacob** is studying polymers at U. Mass., Amherst. . . . **Scott Geels** is finishing his co-op at Martin Marietta in Denver.

Nancy Wang is finishing her second degree. . . . **Tony Pangan** and **Kai-yee Ho** are graduate students at MIT. . . . **Jim Powers** and **Annabel Nickles** are at U.C. Berkeley working on their PhDs, and **Rachel Duncan, Chris Rehmann,** and **Dave J. Miller** (course 3B) are at Stanford. All of them survived last year's earthquake in pretty good shape. . . . **Brian Murphy** is finishing his six months at IBM in San Jose. Brian said he got a great roller coaster ride during the earthquake. . . . **Curtis Eubanks** works at Sony in Tokyo, Japan. . . . **John C. Wang** is at Lotus in Cambridge. . . . **Bill Mahoney** is at Rohm and Haas in Philadelphia. . . . **Jeff Polevoy** works at Monitor Co., near Lechmere. . . . **Chris Kronich** works at Harken in Pewaukee, Wisc., designing sailboat parts.

Jeff Hornstein writes to say that he is now a "professional fraternity man" and loves it. Jeff is employed by Zeta Psi International Headquarters as a travelling chapter consultant. He's been to Vancouver, Boulder, Chicago, Indianapolis, Champaign, Hanover, New Haven, Brunswick, Ann Arbor, Minneapolis, Lincoln, Austin, New Orleans, Charlottesville, and Lexington—all in six months! Jeff hopes to start pursuing his Ph.D. in political science in the fall, possibly at Minnesota, Michigan, or Illinois. Jeff writes that he saw many classmates at the MIT New York Alumni Club gathering, including **Jackie Berger, Carolyn Zehner,** SAE brothers **David J. Miller** and **Andy Brosoff,** and his Zeta Psi pledge brother, **Frank Oh.** After enjoying the free food, they ventured out for a night in the New York bars. Frank works for Kidder Peabody on Wall Street as a financial analyst, and lives in Brooklyn. . . . Seen at the Head of the Charles by Jeff was **Tim Collins,** who works for Prudential-Bache in Boston, but is on assignment in Puerto Rico. Also on his travels Jeff ran into Shane Arnold, '87, who works at the Travellers Insurance Co. . . . Jeff also reports that **Mike Phinny** is getting married to his Simmons sweetheart this winter. . . . **Steve Towle** is pursuing his PhD in materials science at Stanford, but is seriously considering returning to MIT, because the research at Stanford is "boring" and the rugby club is not up to par. . . . **Howie Fox** is at the University of Arizona working on a master's and is also contemplating returning to MIT. . . . **Chris Madden** lives in Watertown with **Warren Brown** and works for a bank in Boston. . . . **Erik Lickerman** is at the University of Illinois Med School, and Jeff says he probably enjoys dissecting cadavers.—**Henry Houh,** secretary, 5380 Hollow Dr., Bloomfield Hills, MI 48013

COURSE NEWS

I CIVIL ENGINEERING

Boris W. Boguslavsky, ScD '38, had a great tour of Russia last summer with six members of his family. He visited Leningrad and Moscow and traveled eight days by river ship on the Don, the Don Canal, and the Volga, with stops in five cities. . . . **Michael Bruno,** ScD '86, has been appointed director of the Davidson Laboratory at Stevens Institute of Technology in Hoboken, N.J. . . . **Joanne Chirichella,** SM '89, married Richard J. Klouda last September. She is working as a project engineer for Exxon Research and Engineering Co. in New Jersey.

In sunny Hawaii, **Stanley K. Kawaguchi,** SM '64, is the vice-president and regional manager (Pacific Basin Region) of Parsons Brinckerhoff Quade & Douglas, Inc. A member of the American Consulting Engineers Council's Planning Cabinet, he is also secretary of the Hawaii Community Development Authority. . . . **Roger Arndt,** PhD '67, is spending his sabbatical leave at the Versuchsanstalt Fur Wasserbau, Oskar V. Miller Institut, Obernach, West Germany on an Alexander von Humboldt Scholarship. He is devoting time to writing and cavitation research, he writes, "and what a setting in the Bavarian Alps! Returning to my position as director of the St. Anthony Falls Hydraulic Lab at the University of Minnesota is going to be tough!"

James V. Hamel, SM '66, of Hamel Geotechnical Consultants, Monroeville, Penn., served as a special consultant on a 30-million-cubic-meter landslide in Papua, New Guinea during the summer of 1989. . . . **Dennis B. McLaughlin,** associate professor of civil engineering at MIT, has been named to the Winslow Career Development Chair for a two-year period ending in June of 1991. McLaughlin came to the Institute in 1984 and his principal fields of interest are stochastic hydrology, design of groundwater monitoring programs, and water resource applications of estimation and control theory. The Winslow professorship was established in 1971 as a memorial to Gilbert W. Winslow by his parents Edward W. and Lena B. Winslow.

HMM Associates, Inc., has announced that **Thomas N. Harvey,** PhD '72, joined the firm as manager of the Transportation Division. In his new role he will be expanding HMM's capability to provide services including transportation systems planning for railroads, airports and airlines, and public transport agencies, as well as roadways, traffic engineering, transportation access plans, traffic impact studies, and planning studies. . . . John A. Rollwagen, '62, chairman and CEO of Cray Research, Inc., presented a Gigaflop Performance Award last fall to **Christopher N. Moran,** SM '81. Moran, who is a presales analyst at Cray in Darien, Conn., was one of twenty computational researchers recognized for doing real-world work on Cray Research machines at speeds of more than one billion calculations per second (one gigaflop). Moran's research interests include computational finance and computational mechanics. "His work with supercomputers and sophisticated software has enabled traders in the financial industry to sift through data and make complex calculations quickly, and to transfer processed information to customers on a timely basis," noted a Cray news release.

Brian R. Brenner, '82, a civil/structural engineer and computer expert in Parsons Brinckerhoff's Central Artery project office in Boston, was awarded the 1990 William Barclay Parsons Fellowship for his proposal to develop an automated analysis and design software system for cut-and-cover tunnels. The new computer software will significantly reduce the amount of manual calculation currently required for the different aspects of cut-and-cover tunnel preliminary analysis and design. The award is meant to recognize and encourage talented technical professionals by supporting their development of new methods and techniques that will advance the state of the art in an area of professional practice important to the firm. **Sam S.C. Liao,** PhD '86, a senior geotechnical engineer who is also in the firm's Boston Central Artery project office, was a finalist in the competition. Liao's research will involve the evaluation of the modulus of subgrade reaction, which is an important parameter used as input for the design of beams on elastic foundations.

The Alumni/ae Association has been notified of the following deaths: **Louis H. Roth, Jr.,** SM '47, of Denver, Colo., died on May 25, 1989. . . . **Alexander P. Hrennikoff,** ScD '40, of Vancouver, B.C., died on January 1, 1985; **Dale E. Lockard,** SM '49, of Mechanicsburg, Penn., died on January 3, 1989. No further information was provided.

II MECHANICAL ENGINEERING

Fred Landis, ScD '50, has been elected an honorary member of the American Society of Mechanical Engineers. . . . **Bulent E. Platin,** ScD '78, writes that after spending a one-year sabbatical leave from the Middle East Technical University of Turkey at the University of Connecticut as a Fulbright Scholar, he has extended his stay at UConn for another year till September 1990, as a visiting professor. . . . Married last October, **David A. Hablanian,** SM '84, is a senior consultant with Arthur D. Little, Inc., in Cambridge, Mass.

A paper entitled "Some Observations on Erosive-Abrasive Wear of Metallic Surfaces in Particular Geometries" won **M. Tayeb Benchaita,** PhD '80, an Alfred E. Hunt Award from S.T.L.E. for best paper published in 1988. Benchaita is a senior research associate with Pennzoil Products Co. in The Woodlands, Tex. . . . **Don F. Pardo,** SM '80, is chair of the Public Relations Committee of the MIT Enterprise Forum, Inc., of San Diego. He is also the newly elected secretary of the MIT Alumni/ae Club of San Diego. His daughter has a newborn brother and the family resides in Rancho La Costa, Calif.

In the spring of 1989, **Jan A. Gatowski,** ScD '85, was named Outstanding Young Engineer of the Year by the S.E. Michigan chapter of the ASME. . . . **Jon A. Andresen,** SM '73, is senior technical analyst at United Airlines with responsibility for implementing new technologies at the $1 billion/year maintenance facility. . . . **Ira L. Meyer,** SM '36, of Boynton Beach, Fla., retired in 1980. . . . **Antonio C. Gominho,** SM '79, has been promoted to senior engineer, Turbine Aerodynamics, at General Electric in Lynn, Mass.

Gerald A. Frederiksen, SM '59, is president of Tactical Truck Corp., in Livonia, Mich. . . . **Jack B. Chaddock,** ScD '55, served as general chair for the XXI ICHMT Symposium on "Heat and Mass Transfer in Building Materials and Structure," held in Dubrovnik, Yugoslavia, in the fall of 1989. He is a member of the NAS/NRC Panel on "Buildings and Community Systems," part of a study team set up to evaluate the effectiveness of U.S. government research in reducing greenhouse gas emissions and recommend new research to effect reductions to 35%-50% by 2010 and 90% by 2050. Chaddock will retire from Duke University in May 1990 after serving 20 years as chair and professor of the Mechanical Engineering & Materials Science Department (1966-1986), and the past three years (1987-1990) as associate dean for R&D in engineering.

In Madison, Wisc., **John J. Moskwa,** PhD '88, is an assistant professor in the Department of Mechanical Engineering at the University of Wisconsin. He won two major teaching awards in his first year: Pi Tau Sigma's Distinguished Faculty Award and Polygon Engineering Council's Outstanding Instructor Award. . . . **Long T. Tran,** SM '80, sends an update on the Decatur, Ala., Refrigerator Plant Modernization: "We are now one



S.S.C. Liao



B.R. Brenner



T.N. Harvey



C. Graham

month into production of new 14- and 16-cubic-foot models and already we have exceeded our production and quality goals, thanks to the dedication and hard work of the employees in Alabama!" Tran and his wife have been married for over a year. She is a junior in chemical engineering at the University of Louisville, Ky., where they reside.

Mike Connolly, SM '82, left the Navy after completing a tour of duty teaching physics at the U.S. Naval Academy. He is completing an MBA at Stanford University and working part-time at Hewlett-Packard. After graduating this year, he will be looking for work in a high-tech company or start-up venture. . . .Lieutenant **Glenn A. Piper,** SM '85, and Lieutenant **Heide Marie M. Stefanyshyn-Piper,** SM '84, were responsible for the successful salvage of the 80,000 ton *Exxon-Houston* off Barbers Point, Oahu, Hawaii, in March 1989. Piper is the project manager for the $300-million overhaul of the USS *Bremerton* (SSN-698) at Pearl Harbor Naval Shipyard. Stefanyshyn-Piper is the assistant planning officer at the Pearl Harbor Intermediate Maintenance Activity.

The prestigious David W. Taylor Medal, presented by the Society of Naval Architects and Marine Engineers (SNAME). was recently bestowed upon Captain **Clark Graham,** PhD '69, USN. The award, given annually for "notable achievement in naval architecture," recognizes Graham's leadership in challenging old ideas with creative solutions. He was cited for guiding the development of an innovative propulsion system concept built around integrated electric drive technology during the early design phases of the DDG-51 Arleigh Burke class destroyer from 1980-85. Graham has been commander of the David Taylor Research Center since 1987, where he "has stretched the boundaries of imagination to create a vision for a radically different generation of warships for the 21st century Navy," said a press release. . . . University of Miami Professor **Harry DeFerrari,** SM '61, is one of five university researchers to receive the Office of Naval Research's new Ocean Science Educator Award. Given for the first year, the award recognizes outstanding ocean science researchers and educators. Each winner will receive grants of $75,000 per year for the next three years. DeFerrari is a specialist in underwater acoustics. **Erich P. Ippen,** '62, professor in the EECS department at MIT, received the first Harold E. Edgerton Award from the Society of Photo-optical Instrumentation Engineers (SPIE) for his work in ultrashort (picosecond and below) optical-pulse generaton technologies.

MIT Professor **Borivoje B. Mikic,** ScD '67, chair of the Department's Thermo-Fluid Sciences Division, received the Heat Transfer Memorial Award in science from ASME. Mikic was recognized for "more than two decades of significant research, notably in the areas of condensation and boiling, thermal conduction and contact resistance, bio-heat transfer and convective heat transfer augmentation."

Arthur E. Bergles, '57, dean of engineering at Rensselaer Polytechnic Institute, Troy, NY., has been elected president of ASME, effective June 1990. Long active in ASME, Bergles has served as chair of several ASME Heat Transfer Division committees, as an editor of the *Journal of Heat Transfer,* and as chair of the division. He was ASME vice-president for professional development and a two-term governor of the Society. Bergles served on the staff & faculty at MIT from 1962-69. His research interests include heat transfer enhancement, two-phase flow and boiling heat transfer, heat recovery heat exchangers, and cooling of microelectronic equipment.

Fred Landis, ScD '50, professor of mechanical engineering at the University of Wisconsin-Milwaukee, was named an honorary member of ASME. Landis was honored for his contributions to mechanical engineering teaching and research through his publications and speeches which have "clarified the challenges facing mechanical engineers and engineering education and have led to a better understanding of engineering manpower planning and the use of engineers in industry."

The following have been elected to Fellow grade of ASME: **Kenneth Norman Astill,** PhD '61, professor of ME and associate dean of engineering at Tufts University. In the area of applied thermal fluid sciences, he is best known in the field of rotating flows. He has contributed to this field through his teaching, research, and co-founding of the Taylor Vortex Flow Working Party international symposium series and applications in electronics, navigational guidance (which led to the innovative thermal design and analysis of the gimballed inertial guidance system of the Trident II missile), internal combustion engines, and power turbines. Astill is the author or co-author of more than 40 technical publications. **Jack B. Chaddock,** ScD '55, associate dean of engineering at Duke University. His work in the field of heat and mass transfer in two-phase fluid systems led to a Fulbright Lectureship in Helsinki, Finland. Chaddock's research on boiler refrigerants in tubes employed the novel approach of using a glass tube with a transparent, electrically conductive coating on the tube. This provided visual information on bubble formation as well as qualitative data on heat transfer. The result was an improved refrigerator evaporator design. Chaddock is the author or co-author of more than 40 technical publications. **Gershon Grossman,** ScD '71, professor at Technion-Israel Institute of Technology. He has specialized in the thermal sciences and for the past 15 years has conducted research on solar energy and energy conservation. He is an internationally recognized authority on absorption heat pump technology and his contributions have led to advances in water desalination, solar-powered air conditioning, waste heat recovery by heat transformers, absorption systems simulation, and fundamentals of heat and mass transfer in film absorption. Grossman is the author or co-author of more than 80 technical publications and holds four patents.

Fred Bartlett, SM '78, a co-founder of WeatherTrac Industries, has developed the software for WeatherTrac, a personal-computer-based weather-satellite image system. The new product is directed toward marine, agriculture, aviation, broadcast, utility, meteorology, education, and military uses. . . . **Tom Sheridan,** ScD '59, was honored by his friends, past students, and colleagues on his 60th birthday for his years spent on human machine system research. A surprise party was held at the MIT Faculty Club on November 17, 1989. Over 100 people from all over the globe were there to present Sheridan with a draft festschrift—a set of scientific papers dedicated in his honor. When completed, the book will be published by Taylor & Francis, Ltd.

Millard Dowell, SM '40, died on October 12, 1989, in Erie, Penn. Dowell was a member of ASME and an electrical engineer at General Electric Co. for 42 years. He was a member of Wayside Presbyterian Church where he had been a trustee and deacon.

III MATERIALS SCIENCE AND ENGINEERING

Kenneth R. Bain, PhD '83, is now president of the Materials Behavior Research Corp. in Loveland, Ohio. MBRC performs research on the mechanical behavior of materials and is a leader in the area of intermetallic composites. . . . **George Krauss,** ScD '61, received the 1988 Colorado School of Mines Haliburton Faculty Award for outstanding professional achievement. He was elected president of the International Federation of Heat Treatment and Surface Engineering for 1989-1990. Krauss is also a director of the Advanced Steel Processing and Products Research

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K.A. Dannemann R.D. Haggarty

Center in the Colorado School of Mines. . . . In 1988, **Edward R. Funk,** ScD '51, sold Funk Fine-Cast Corp. of Columbus, Ohio, a precision casting operation that he started in 1970. He is still president and CEO of Danninger Medical Technology, Inc., a publicly held company in the medical instrument and implant field. Funk also serves as president and CEO of Superconductive Components, Inc., also publicly held, which manufactures and distributes high-temperature superconductive components and devices.

HDTV has a fan in **D. L. Ritter,** ScD '66. As a congressman from Pennsylvania, he has been in the forefront of the battle for an American presence in high-definition television. Ritter's bill making October National Quality Month was signed by President Bush in the Oval Office, kicking off a nationwide, monthlong focus on quality as the key to U.S. competitiveness. . . . Another Pennsylvanian, **Stefan J. Garvin,** SM '50, is vice-president of his own company, Electrical Energy Enterprises, Inc. He is princapally involved in materials and international marketing consulting. The company does extensive business for Mexican-border and Caribbean assembly operations and the marketing of U.S. products in the Orient, especially Japan.

Marc LaBranche III, PhD '85, has been promoted to staff research metallurgist in the Electronics Department at DuPont in Wilmington, Del., and he is enjoying the second year of marriage. His wife Celia is a grad student at the University of Pennsylvania in immunology. . . . **Ramon (Ray) K. Robinson,** ScD '73, has been busy since leaving Exxon Enterprises in 1986. He is a senior partner and director of R.L. Ferguson, Inc., a management and holding company specializing in three strategic business areas: energy production and distribution, nuclear and hazardous waste, and capital formation. The Ferguson Co., headquartered in Kennewick, Wash., works with and for national and international corporations. In addition, Robinson is the founder and principal of Xcel Ventures, Inc., a Pacific Northwest venture capital general partner in the process of forming a venture capital limited partnership. He is also president of Robinson, Inc., and co-founder of Paladin, Inc.

Kathryn A. Dannemann, PhD '89, has joined the GE R&D Center as a metallurgist. She is a member of the American Society for Metals, the Minerals, Metals and Materials Society, the American Ceramic Society, and the Society of Women Engineers. . . . **John Zotos,** MTE '67, was one of six recipients of the 1989 Outstanding Alumni Award from Northeastern University. The awards are presented annually to "those graduates whose professional attainments and service to the community bring honor upon themselves and upon Northeastern." Zotos has been a member of the university faculty since 1960 and is currently a professor of mechanical engineering. He has conducted research and consulted for companies and government agencies in the area of metallurgy. He is involved in educational, professional, and community organizations; active in the Greek Orthodox Church, he is a member of the Diocese of Boston Mixed Council. He is also involved with the College of Engineering as faculty advisor to Tau Beta Pi and the Engineers' Council as well as a member of the Committee on Minorities.

IV ARCHITECTURE

V. Boone Powell, MCP '60, served as chair of the American Institute of Architects Committee on Design. Boone led a 50-member AIA group to Helsinki, Finland, for a jointly sponsored AIA/Finnish Society of Architects international conference on design. . . . **Gerald W. Billes,** MAR '72, is an owner of Billes/Manning Architects, the design architects for the construction of the Aquarium of Americas and Convention Center expansion in New Orleans, La. His firm is also designing a complete concourse for the New Orleans Aviation Board. . . . *Dwellings, Settlements & Tradition,* edited by **Nezar Alsayyad,** SM '81, was published by University Press of America last September. Alsayyad is also the editor of the new quarterly journal *Traditional Dwellings & Settlements Review,* the first issue of which appeared last October and is supported by a grant from NEA. As executive director of IASTE (International Association for the Study of Traditional Environments), Alsayyad will be heavily involved in the organization of the next international conference sponsored by IASTE, entitled "First World/Third World: Duality and Contradiction in Traditional Dwellings and Settlements."

Rod Freebairn-Smith, MAR '61, was competitively awarded the commission to design an expansion of Stanford University's Mechanical Engineering Department and Building 610. He is the mayor's appointee to the Strategic Planning Group for all port lands in San Francisco. In the spring of 1989, Freebairn-Smith was elected president of (10,000 population) Telegraph Hill Association in S.F. . . . From Duxbury, Mass., comes news of **Alex Loy Seid,** MAR '74, who is back in graduate school at Boston University as a part-time student in the MBA program. Seid is an appointed member of the Duxbury Design Review Committee. . . . **Craig A. Whitaker,** MAR '83, writes that after graduation in 1984, he and **Hank Reisen,** MAR '83, started Whitaker-Reisen Construction Corp. After the first year Reisen sold his interest and began his own architectural design firm. Whitaker's firm is now known as Whitaker Construction Corp. and is located in Somerville, Mass. Five years after starting, the firm has grown to a staff of 12 people, including carpenters, designers, and administrative staff. They are specialists in design/build work for high-end residential and also do some commercial work such as the Building 7 Corridor Gallery completed in 1985 for the MIT School of Architecture. The firm's sales volume is now over $2 million per year.

Russ V.V. Bradley, Jr., MAR '71, is now an international lawyer (Harvard, 1978) living and working in Geneva, Switzerland, with his wife Catherine, a Swiss lawyer (and Julia, born in May 1989 in Lausanne). Bradley finds that architecture is better lived than practiced. He works in a 19th-century section by the lake, lives in an 18th-century Italian Quarter of Geneva one kilometer from France, and takes lunch in the medieval "Vielle Ville" in between. Through the tunnel at the end of the lake is Italy. He says that even if friends do not have legal business in Europe (his firm has just formed a partnership with English solicitors in London and the Island of Jersey), or money to invest in a Swiss bank (the firm shares a floor with and a stake in a small private bank/investment manager), then call him anyway and stop by for skiing, hiking, sightseeing, or just looking at architecture.

William R. Bertsche, MAR '74, is a partner with Mercer & Bertsche located in Old Mystic, Conn. He was formerly a vice-president of business development for Ship Analytics in North Stonington, Conn. . . . *Downtown, Inc.: How America Rebuilds Cities,* (MIT Press), is a new book by **Bernard J. Frieden,** PhD '62, and **Lynne B. Sagalyn,** PhD '80 (XI). Both authors are in the Department of Urban Studies and Planning at the Institute. Frieden recently completed a term as Chair of the MIT Faculty and is the Ford Professor of Urban Development. Sagalyn is associate professor of planning and real estate development. The book, a progress report on our cities, "surveys the results to date [of several studies] to see if there is a real agenda for downtown in the mix of convention centers, malls, stadiums, hotels, and promotional events." . . . **Ellen Shoshkes,** MAR '77, of Hoboken, N.J., has written *The Design Process: Case Studies in Project Development* (Watson-Guptill). The book is comprised of nine innovative projects, followed through the design process, that show how excellence in design can be achieved while still meeting the needs of the community. One of the projects, The Village Center, is by **William Rawn** [MAR '79] Associates.

Linea 5, inc., founded in 1985 by **Rosemary Grimshaw,** MAR '78, and **Michael Slezak,** MAR '78, has merged with Gerald Foster, inc. With Linea 5's name and Cambridge location, the merged company will have additional expertise in the design of laboratories and medical facilities. Current Linea 5, inc. projects include an AIDS Research Laboratory for Harvard University's School of Public Health, new facilities for Cambridge Analytical Assoc. in Bedford, the first remote site for Children's Hospital in Lexington, and projects for pharmaceutical start-up companies. . . . Benjamin Thompson & Associates, architects and planners, has been joined by **George T. Tremblay,** '75. Tremblay, formerly of Perry Dean Rogers & Partners, has served as project architect on a variety of educational and health-care facilities including the Wellesley College Science Center, Killian Recital Hall at MIT, the Boston University Stone Science Center, and Metpath Laboratories in Boston. Tremblay is managing BTA's work on Park-in-the-Valley, a 23-acre mixed-use development in Mission Valley, San Diego, Calif.

Stephen A. Kaufman, MCP '40, of Claremont, Calif., died on April 4, 1989. After working as a project planner expediting war housing for the federal Public Housing Authority in New York, in 1943 Kaufman became a planner for the city of Cleveland with responsibility for transportation plans, and a chief planner, deputy director, and acting director for Cleveland's Regional Planning Commission. He was responsible for a comprehensive seven-county transportation and land-use study in the greater Cleveland area, as well as many other planning projects. While in Cleveland, Kaufman taught planning at Case Western Reserve University and was very active in the planning professional organization, now the American Planning Association, of which he was national vice-president in 1966. In Claremont, he taught planning at California State Polytechnic University and was a member of the Sierra Club, where he participated in many committees.

Christopher McIee Lyon, MAR '88, of Cambridge, Mass., died of melanoma on October 21, 1989. Lyon, whose designs for residential and public structures reflected his deep interest in closely integrating nature and technology, received the Alpha Rho Chi award upon graduating from MIT. The award is given for leadership, service to the school and department, and promise for real professional merit. His other pursuits included an interest in the history of naval architecture and shipbuilding, a children's book which he wrote and illustrated and intended to publish, and a book under contract with David Godine Press in Boston which was to be the *Illustrated History of the* Flying Cloud *Clipper Ship.*

V CHEMISTRY

John P. Fackler, Jr., PhD '60, has completed a year as chair of the board of trustees at Gordon Research Conference. . . . **Richard P. English,** PhD '70, is COO of Alameda Instuments, Inc., a

start-up company that produces acid reprocessing equipment for high-purity applications. . . . **David P. Toorchen,** PhD '81, writes that he is working at Chemical Abstracts Services with linguists and scientists. He is also working with American Atheist, producing a cable-access TV show "to slow the individuals determined to replace science with biblical inerrancy." He reports he placed fourth in the company tennis ladder, down one from last year. . . . **Jacob A. Marinsky,** PhD '49, is professor of chemistry emeritus at SUNY/Buffalo.

J. Stuart Fordyce, PhD '59, was the 1988 Distinguished Space Technology Lecturer at Columbia University. He was a guest lecturer at the 1989 International Space University and also at the Universite Louis Pasteur in Strasbourg, France, during the summer of 1989. . . . From San Diego, Calif., **Christopher Reiser,** PhD '80, reports he is the director of technology at Cymer Laser Technologies, a maker of excimer laser systems for the semiconductor industry. . . . **Gail L. Burnett,** PhD '80, is manager of Specialty Technologies Operations for DuPont in Billerica, Mass. . . . Retired from Eastman, **Louis D. Moore,** PhD '51, is in the People's Republic of China teaching English at the University of Petroleum Dongying in Shandong Province through the English Language Institute of China. He will return at the end of July.

Harvey S. Trop, PhD '79, of South Plainfield, N.J., reports the birth of his daughter, Kelly Lauren Trop, on July 9, 1989. . . . **Arnold Schwartz,** PhD '74, published a pathology textbook entitled *Intraoperative Consultations* (American Society of Clinical Pathologists Press, Chicago, 1989). . . . Tufts University's board of trustees has promoted **Terry E. Haas,** PhD '63, to full professor on the chemistry department faculty. The former Fulbright Scholar's research interests include physical inorganic chemistry. . . . **James J. Burke,** PhD '62, has been appointed a senior fellow at Monsanto Corporate Research in St.Louis, where he conducts research on synthetic polymers in biological applications.

The Alumni/ae Association has been informed of the death of **Allan Y. Teranishi,** PhD '73, of Berkeley, Calif., who died on March 9, 1982. No further information was provided.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Gordon K. Harris, Jr., SM '66, is a patent attorney and partner with Harness, Dickey & Pierce in Troy, Mich. . . . **Frank P. Zaffarano,** SM '47, retired from Gould Inc.'s Recording Systems Division in 1987, but was called back in 1988 to design servo drive microchips. In 1988 he retired again and is now busy organizing the 1992 (50th reunion) anniversary of his 1942 graduation from Case Institute of Technology.

University of Toronto President Emeritus **James M. Ham,** ScD '52, is president elect of the Canadian Academy of Engineering and an advisor to the president of the Canadian Institute of Advanced Research. . . . **Raymond W. Kinsley, Jr.,** EE '68, writes: "In this throw-away society, I'm still trying to determine whether it would be worthwhile to recycle old electronics or build equivalent replacement parts from available stock supplies."

Randal E. Bryant, PhD '81, is an associate professor of computer science at Carnegie Mellon University. He received the 1989 W.R.G. Baker Prize Paper Award from the IEEE. This award is given for "the most outstanding paper reporting original research in any IEEE proceedings, or transactions, or journal." It was presented for a pair of papers that appeared in the July 1989 issue of *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*. . . . **Spyridon (Spiro) Armenis,** EE '75, is developing a new business called Pascall Group, Inc., in Melbourne, Fla. The marina management and development firm is attempting to provide much-needed marina space for boats.

Leonard Kleinrock, PhD '63, writes that in addition to his full-time position as professor of computer science at UCLA, he has founded his third company, The Computer Channel, Inc. The company broadcasts live computer seminars via satellite directly into corporate offices. . . . **William M. Crampton,** SM '55, retired from Honeywell, Inc., in 1986 after more than 31 years of service. He and his wife, Jeanne, left Minnesota for rural Bear Lake, Mich., in 1988. They spent the following year winterizing their small summer cottage for year-round use. In 1989 they built an addition and will be doing interior finishing over the winter. Crampton keeps busy with community activities, folk music association, conservation club, cross-country skiing, etc. He hopes to do some ice fishing this winter right out his front door and has no plans of going south—"can't stand crowds in Florida, Texas, and Arizona!" he says.

After graduation, **Walter Hamscher,** PhD '88, worked four months at Schlumberger Technologies Laboratories in Palo Alto, Calif., on automated diagnosis of VLSI chips using electron beam probing. Since then he has been employed by Price Waterhouse Technology Centre in Menlo Park, Calif., using AI approaches to qualitative modeling in management applications. His first son, Peter Michael, was born May 7, 1989. . . . **Al Gasiewski,** PhD '89, is an assistant professor of electrical engineering at Georgia Tech. He has been teaching courses in electromagnetics to both undergrads and grads and is starting a research program in atmospheric remote sensing. . . . **Edwin Zenith Gabriel,** '51, of Ocean Grove, N.J., received patent #4865372 entitled "shovel-like digging, scooping and transporting apparatus with back-strain relief features" on September 12, 1989. He reports that it is "an inexpensive tool for poor people to do gardening, fishing, and other tasks to provide food for their families." He expects to receive an Australian patent for "tongs-like cable-scooping coupling device for suspended loads." It is an inexpensive cargo hook with automatic loading and unloading features.

Newport Electronics, Inc., of Newport Beach, Calif., has named **Norman E. Gray,** SM '53, as a director. Gray will remain a consultant to Actioncraft in Anaheim, Calif. . . . **Terrence P. McGarty,** PhD '71, of Florham Park, N.J., is corporate director of research at NYNEX Corp. His third book, *Business Plans that Win Venture Capital* (J. Wiley & Sons) was published this past spring. He has a lecturer appointment at MIT teaching a course called "Multimedia Communications." McGarty is a sponsor of the MITES program and has past MITES students working in the research department at NYNEX. **Ralph W. Rothfusz,** SM '60, has been named president of Teledyne Precision-Cincinnati, designer and manufacturer of automatic assembly systems, automatic arc and resistance welding machines, and special packaging systems. Most recently he served as vice-president of operations for the Oldenburg Group, Inc., of Milwaukee, Wisc. . . . *The Age of Electronic Messages* (MIT Press), by **John G. Truxal,** '47, is due to be published in early 1990. According to early page proofs, the book explains the scientific principles on which this technology is based and explores its capabilities and limitations, its risks and benefits.

The 1989 Kyoto Prize for advanced technology was awarded to **Amos Edward Joel, Jr.,** '40, for his contributions to electronic switching technology for communications networks made over a 43-year career at AT&T Bell Laboratories, Murray Hill, N.J. The prize carries an award of 45 million yen (approx. $345,000). For the last six years, Joel has been a consultant based in South Orange, N.J. The Kyoto Prize is administered by the Inamori Foundation, established by Kyocera Corp. . . **Edward Lassiter,** SM '59, of Rancho Palos Verdes, Calif., has been appointed group vice-president of development at The Aerospace Corp., a Federal Contract Research Center providing technical, scientific, and engineering services, primarily for the U.S. Air Force. Lassiter has been with the company since 1962. . . . **Jim Moran,** PhD '68, who heads the radio and geoastronomy division of the Harvard-Smithsonian Center for Astrophysics, is known for his pioneering work in very long baseline interferometry. Recently promoted to full professor, Moran, with his colleagues and students, employed clever geometry to determine the distance to new stars after tracking for three or four years the movements of the celestial fireworks set off by the birth of new stars. Their technique is one of the few direct ways that astronomers have of measuring cosmic distances.

Ronald D. Haggarty, SM '61, of Wayland and Falmouth, Mass., has been elected vice-president of research and technology of the MITRE Corp., in Bedford, Mass. Promoted from director of research and technology, he has oversight of the company's entire activities in this area for Department of Defense clients as well as civilian government agencies.

President Bush presented **Robert R. Everett,** SM '43, former president and CEO of the MITRE Corp., and **Jay Forrester,** SM '45, MIT professor emeritus and School of Management senior lecturer, with the Medal of Technology, the nation's highest honor for technology. The honor is awarded annually by the president to recognize individuals or companies who have made exceptional contributions to the well-being of the nation through the development or application of technology. The joint award was presented to Everett and Forrester as managers of Project Whirlwind, which began in 1944 as an idea for a universal flight trainer and aircraft simulator. Developed at MIT for the Navy, it soon became much more: the first general-purpose, high-speed, real-time, parallel synchronous, electronic, digital computer. The award citation reads: "For their creative work in developing technologies and applying computers to real-time applications. Their important contributions proved vital to national and free-world defense and opened a new era of world business."

The Alumni/ae Association has been notified of the death of **Jacob J. Jaeger,** SM '34, of Cary, N.C., on December 15, 1987. No further information was provided. . . . **John P. Shannon,** SM '63, of Escondido, Calif., died on September 2, 1989. He was an electrical engineer and chief scientist at Maxwell Laboratories, Inc., in San Diego, Calif. He was noted for his 25 years of technical work in high voltage and its applications to high-energy particle and nuclear physics.

VI-A INTERNSHIP PROGRAM

Br-r-r, as I write this Dec. 22, 1989, "baby it's cold outside"; wind-chill factor of -31ºF this morning; coldest December on record since the Boston office of the Weather Bureau started keeping records. Top of nearby Mt. Washington, this morning, had wind chill of -89ºF! I guess some of the rest of you throughout the United States have had similar experiences this year. What happened to the "greenhouse effect"? The temperature hasn't slowed things down around MIT, though.

A VI-A alum, **Amar G. Bose,** ScD'56, founder of Bose Corp., Framingham, Mass., along with the Bose Foundation, has established the Amar Bose Teaching Award in the School of Engineering. This will recognize outstanding contributions to undergraduate education by faculty members and carries a cash award of $5,000. The first award will be made in March. Bose was VI-A faculty advisor to G.E.Co./Space Systems Division/Valley Forge, Penn., when I first became VI-A director back in 1969, and I've maintained my contact with him.

The name of Professor **Yuk-wing Lee,** ScD '30, will be familiar to some of you. I'm sorry to have to report that Lee, who had retired to Belmont, Calif., died on Nov. 8, 1989.

The announcement of this year's Marshall Scholarships brought the name of VI-A'r **Joseph**

R. Babiec, Jr., '90. Joe is this year's president of MIT's Mass. Beta Chapter of Tau Beta Pi. **Kevin J. O'Toole,** NE '57 (XIII) and I currently serve on the chapter's advisory board. Marshall Scholars must demonstrate outstanding academic achievement and a capacity to make a significant contribution to society. They spend a period of time studying at British universities.

The Alumni/ae Association has established a new community service project in the Boston area to provide an activity for local alumni/ae from the 10 most recent classes. In its first-of-a-kind project, the group, which included **John R. Canfield,** SM '87, created a play area at a women's advocacy daytime center in Boston's South End neighborhood.

Noted in the December issue of the IEEE Boston Section's bulletin *The Reflector* are presentations by two VI-A grads. **Jeffrey M. Blacksin,** SM '83, president of CIMTRON of Marlboro, Mass., to a meeting of the Control Systems Chapter; and **Richard S. Withers,** ScD '78, associate group leader at MIT Lincoln Laboratory, to a meeting of the Aerospace & Electronic Systems Chapter. Jeff stopped by the VI-A office one day where he told me about his new venture, CIMTRON, which combines people, computers, and manufacturing equipment into one coherent environment.

The Fall 1989 issue of Northeastern University's *College Of Engineering Newsletter* carries an article about a new joint MSEE program at NU with the General Electric Co. A member of the joint degree planning group is Professor **Carey M. Rappaport,** PhD '87. Nine promising young practicing engineers, designated by GE as "Edison Engineers," will begin master's work at NU in September. Carey joined the faculty at NU and recently married Ann W. Morgenthaler (daughter of our Professor **Frederic R. Morgenthaler)** who is doing graduate work in Course VI.

A December 18, 1989, Research Review held by MIT's Microsystems Technology Laboratories had several VI-A's as co-authors of presented papers. They were **Kathy S. Krisch,** SM '88, **Kenneth K. O,** SM '84, and **Mark W. Reichelt,** SM '87.

Visitors to the office have included: **Stephen M. Foster** who completed his master's work in December and headed off to Germany for a vacation; also Steve gave me a business card from **James Marggraff,** SM '82, whom he had met, which tells me Jim is sales development manager for StrataCom, Inc., in Campbell, Calif.; **Thomas W. Humphrey,** SM '89, who is doing patent law work with a Boston firm and plans on attending law school soon; and a phone call from **Oscar P. Manley,** PhD '60, who is with the Department of Energy in Washington, D.C. Oscar's oldest son is studying for a PhD, second son is in medical school, and daughter works in a bank.

A number of Christmas cards have arrived, and there'll be some more to come, so I'll leave my annual acknowledgement of all of those for the next issue.—John A. Tucker, Director (Emeritus) VI-A Internship Program, MIT, 77 Mass. Ave. Rm 38-473, Cambridge, MA 02139.

VII BIOLOGY

Richard S. Gordon, PhD '54, is a professor of agribusiness and biotechnology at Arizona State University. He also serves as director of that university's Newcast Center, which is devoted to helping scientists/engineers realize the fruits of their ideas. In addition, Gordon is chair, president, or board member of a number of start-up ventures.

VIII PHYSICS

John E. Mekota, '50, of Waltham, Mass., is still enjoying consulting work on computer applications and occasional lecturing at his alma



R.D. Maurer

mater, Doane College. . . . **Sol Aisenberg,** PhD '57, is very active in consulting on diamond-like carbon and thin films, and in developing and licensing technology. . . . **Peter Fowler,** SM '60, is greatly enjoying his retirement. He has crewed on a Morgan 43 to the British Virgin Islands from Marblehead, Mass., and also from Gloucester, Mass., to Portsmouth, Va., on a Newburyport 37. Says he, "am available for anything you need an experienced sailor for." . . . *Fundamentals of Waves and Oscillations* (Cambridge University Press, 1988), is a recent book by MIT Professor **Karl U. Ingard,** PhD '50. He was the initial recipient of the Per Bruel Gold Medal in Acoustics from the ASME in 1989. The medal was established last year in honor of Bruel, a Swedish engineer who pioneered the development of highly sophisticated noise and vibration measuring and processing equipment. Ingard is receiving the award "for his renowned scholarship, seminal contributions to literature, deep physical insight in the physics of acoustics, and inspiration to generations of students and colleagues." His research in acoustics has dealt with noise generation and propagation in jet engines compressors; instabilities in control valves, in jet engine compressor seals, and in other fluid machinery components and devices; sound propagation and absorption; and various other aspects of acoustics.

Louis K. Acheson, Jr., PhD '50, of Encino, Calif., retired from Hughes Aircraft Co. in late 1989 after 40 years of "interesting work, always at the leading edge of technology," he writes. His last position was that of chief scientist in the Systems Design Laboratory of the Space and Communications Group. He is looking forward to pursuing a variety of other interests that have been demanding increased attention, relating to the problems of society and design of improved social systems. . . . **H. Henry Stroke,** PhD '55, is serving as chair of the Department of Physics at New York University. He is in collaboration with CERN and the French Laboratory for Space and Planetary Science, developing a new type of particle (alpha, beta, X rays) spectrometer based on calorimetry at millikelvin temperatures. Stroke's motivation: a measurement of the neutrino mass.

Head of the Fusion Systems Division in the Plasma Fusion Center and Senior Research Scientist in the Nuclear Engineering Department **Daniel R. Cohn,** PhD '71, is doing research on fusion ignition in high-field tokamaks. He is also working on laser interactions with plasmas and solids and properties of high temperature superconductors. . . . **Andrew Cumming,** PhD '89, is a postdoctoral fellow in physics research at AT&T Bell Labs in Murray Hill, N.J. . . . **Ronnie D. Lipschutz,** SM '78, is president and executive director of the Pacific Institute for Studies in Development, Environment, & Security in Berkeley, Calif. . . . **Josef Eisinger,** PhD '51, is professor of physiology and biophysics at Mount Sinai School of Medicine in New York, N.Y.

George R. Donner, PhD '69, of Fort Wayne, Ind., has been an investment portfolio manager at Fort Wayne National Bank since 1987. Although he still plays oboe, he is no longer with the Fort Wayne Philharmonic, which he was a member of for 12 years. Married for 20 years, Donner and his wife Ann have two daughters, Christa, 14, and Sarah, 10. He taught college physics in Ethiopia, went into real estate, then food processing, and now he is into investments. Donner is studying for a CFA designation. . . . Tufts University Professor of Physics **Yaacov Shapira,** PhD '64, has been awarded tenure. His research interests include experimental condensed matter physics. . . . Reverend **George Brooks,** SM '47, was a guest minister at the Melrose, Mass., Unitarian Universalist Church on October 15, 1989. He has served churches in Burlington, Ind., Bellville and Sandusky, Ohio, and Chattanooga, Tenn.

Karin Rabe, PhD '87, has been appointed the first Clare Booth Luce Assistant Professor of Applied Physics at Yale University. Rabe, who holds an appointment in the physics department, is among the first eight scientists nationwide selected for support by the $70 million Clare Boothe Luce Fund under a new program to boost the ranks of women in science. As a postdoctoral member of the theoretical physics department at AT&T Bell Laboratories from 1987 to 1989, Rabe studied the relationship between crystal structure and superconductivity in the oxide, high-temperature superconductors. She is planning research at Yale on quasicrystals, high-temperature ferroelectrics, high-temperature superconductors, and structural phase transitions. The two primary techniques she uses are the construction of models and calculations involving large-scale computation. . . . **Klaus Fritsch,** SM '65, of Hudson, Ohio, a professor of physics at John Carroll University, has been appointed chair of the university's physics department. Fritsch has been a professor at John Carroll for 22 years.

The Naval Research Laboratory (NRL) in Washington, D.C., has honored recently retired Corning scientist **Robert D. Maurer,** PhD '51, for his pioneering efforts in the development of glass optical fiber for telecommunications. He helped co-invent the first optical fiber with low enough loss (20 decibels per kilometer) to be practical for telecommunications. Maurer has since made other contributions including optical fiber signal loss and mechanical strength.

Nisson A. Finkelstein, PhD '49, of Wilmington, Del., died on October 24, 1989. He was the founder and former president of ILC Industries Inc., which made spacesuits for the Apollo program and continues to produce space garb for NASA. He also was a former chief executive of Inertial Motors, where he helped develop the sophisticated motor that drove the cameras used on moon landings. He was the company's chairman at his death. Early in his career he was the head of R&D at Bausch & Lomb, Inc., and a vice-president of research and engineering at General Dynamics Corp.; later he acquired a division of International Latex Corp. which he later turned into LTC Industries. Finkelstein was also active in community and religious affairs. He was a former president of the Jewish Federation of Delaware and was a board member and former president of Albert Einstein Academy in Wilmington. For the last 10 years, he had written a bimonthly column for the *Jewish Voice,* a Delaware publication, under the pen name of N. Even-Or.

X CHEMICAL ENGINEERING

Ronald A. Sills, PhD '70, was promoted to manager of Research Planning at Mobil R&D Corp. He is a member of the National Research Council's Committee on Production Technologies for liquid transportation fuels. . . . **Bill Van Vorst,** SM '43, of Los Angeles, Calif., has retired after more than 40 years with UCLA's School of Engineering. . . . **Austin W. Fisher,** ScD '41, and his wife Anne lost both their cruising sailboat and their land base on St. Croix to "Hugo." They have decided not to stay there and have taken an apartment in Stoneham, Mass. The move puts them near family and old friends. According to Fisher, there's been "no decision yet on what we will do with our new life, but we have always found plenty to keep us busy."

From Crosby, Tex., **Ernest Ohsol,** ScD '39,

writes that he enjoys doing consulting work in environmental engineering, chemical process design, and plastics formulation. He has six grandchildren and he is learning to shoot a respectable game of pool. . . . **Nelson Bogart,** SM '39, of Atherton, Calif., and his wife just returned from a cruise around the Indonesian Islands on the *Ocean Pearl*. He highly recommends it as a happy and luxurious ship. The Bogarts missed the San Francisco earthquake as a result of their trip. There was no damage to their home or those of their children. . . . **Matt Croughan,** PhD '88, of San Bruno, Calif., married Kathryn Kidd on July 29, 1989. Many MIT alums added to the celebration.

Steve Wilson, SM '75, has been the operations manager (plant manager) at TRW's plant in Mountainside, N.J., since September 1988. He reports that "we manufacture metal fasteners and our operation includes a full tool room, stamping, tapping, heat treating, processing, and assembly. Our processing operations include electroplating, phosphating, painting, and several other things that remind me of my time at the Practice School! It is a challenge and quite rewarding at the same time." . . . As a partner in a Vancouver, B.C., based technology-oriented venture-capital group, **Sam Znaimer,** SM '81, has recently become involved with groups developing solid polymer fuel cells and photovoltaic solar cells. He would love to hear from other grads championing chemical-engineering-related projects.

Colonel **William S. Hutchinson, Jr.,** ScD '49, writes, "As a former commander of the Joint Task Force of Nuclear Testing in 1966, I have just written a letter to the editor of *Chemical & Engineering News* asking what would happen to the fallout if the 'Strategic Defense Initiative' were ever developed, deployed, and so-called 'successfully' used. Perhaps I am overly simplistic, but it seems to me that a world-girdling radioactive cloud would be generated which could not readily be dissipated without considerable harm. Perhaps someone at MIT can calm my concern." . . . **Andrea (Fricke) Tabor,** SM '82, writes from Cleveland, Ohio, that she is self-employed, developing software for engineering applications. Her most recent project is a program for the statistical design of experiments and the subsequent analysis of those experiments. Previously she worked for BP America (formerly the Standard Oil Co.) in various engineering and R&D departments. Tabor is married with three children,and her husband underwrites commercial mortgages.

After 19 years at Abcor Inc. (now Koch Membrane Systems), **William Eykamp,** PhD '65, is visiting professor in the College of Engineering at the University of California, Berkeley. Seven of Eykamp's years at Abcor, Inc. were as president. . . . **Charles P. Marion,** ScD '52, reports that he and his wife Jane visited their first son Peter, born in 1947 at MIT, and his family in Madison, Wisc., for Christmas. Their next planned stop was via San Francisco and Maui to visit second son, **Toby Marion,** SM '71, born in 1949 at MIT, and his family in Bangkok, during January 1990. Toby is a general manager for Caltex Petroleum in Thailand. Charles Marion is still consulting for Texaco Development Corp. . . . **Vikram Kothari,** CHE '84, is now manufacturing and selling process control systems in India.

Chiu-Kin (Steve) Lai, ScD '86, of Somerville, Mass., is a senior scientist at BTU-ULVAC Corp., a joint-venture between BTU International and ULVAC Japan. This venture is established to market advanced semiconductor fabrication equipment in the United States and Europe. Lai is in charge of process R&D of selective tungsten deposition systems for ASIC and ULSI device fabrication. He is also responsible for transfer of deposition technology between ULVAC Japan and BTU International at Billerica, Mass.

Shi-Woo Rhee, PhD '84, returned to Korea in 1986 to become a faculty member at POSTECH (Pohang Institute of Science & Technology), which is a newly founded engineering college by POSCO (Pohang Iron & Steel Co.). Rhee has set up a research group called Laboratory for Advanced Materials Processing (LAMP) in the Department of Chemical Engineering for the development of fine chemical processing of advanced materials and semiconductors. Rhee's current research activities include experimental work on the synthesis of fine ceramic powders and deposition & etching of metallization materials for integrated circuits. Rhee was among nine MIT PhDs and postdocs at POSTECH who were visited by President and Mrs. Gray in November 1989.

Guy Le Pechon, SM '64, reports that after a broad experience in the management of high-technology companies and as a consultant for information systems to support management, he started a new consulting business as one of two partners. The company, called "Europe-Conseil", specializes in information systems, e.g., planning of I.S., distributing expert systems. . . . **Ben J. Lipps,** ScD '66, has been named president, CEO, and COO of Delmed Inc. of New Brunswick, N.J. He continues as president of Fresenius USA Inc., also of New Brunswick, and president of Seratronics Inc., of Concord, Calif. . . . **Robert W. Davis,** SM '50, has been appointed a director of International Technology Corp. of San Ramon, Calif. He recently retired from his positions as president of Chevron Chemical Co. and vice-president of Chevron Corp.

Robert L. Mitchell, SM '47, of Weston, Conn., received the 1989 Bronze Beaver Award from the MIT Alumni/ae Association. The award is given annually to an MIT graduate in recognition of distinguished service to the Institute and/or its Alumni/ae Association. Mitchell was cited for his "invaluable assistance to a wide variety of MIT constituencies that have sought his counsel and help." "Bob's superb efforts in MIT's behalf merit the highest recognition," the citation stated.

Pope A. Lawrence, SM '37, of Bethesda, Md., died on September 26, 1989. He began his career with the U.S. Public Health Service in Texas in 1942 and later worked in New Mexico and Utah. He was transferred to Washington, D. C. in 1952 and was assigned at different times to the National Cancer Institute and the Office of the Surgeon General. Lawrence worked in many areas, one of which was air pollution. At the time he retired in 1979, he was assigned to the EPA where he did liaison work with the DOD. . . . **Roger N. Saleeby, Jr.,** SM '50, of Cos Cob, Conn., died on October 12, 1989. He worked for DuPont, Atlantic Research, and Phillip Morris as a chemical engineer before becoming an independent consultant. A resident of Cos Cob for 24 years, Saleeby served as a member of the Representative Town Meeting and was active as a coach for local Little League baseball and football teams. . . . **Martin R. Smith,** SM '42, of Houston, Tex., died on May 9, 1989. Smith retired from M.W. Kellogg Co. after 42 years of service as a chemical engineer. While at the Kellogg Co., he served as president of the Quarter Century Club.

The Alumni/ae Association has been notified of the following deaths: **Frank Norman Grimsby,** ScD '54, of Houston, Tex., died on July 11, 1989; **Harry E. Trout, Jr.,** SM '39, of Gibsonia, Penn., died on September 27, 1989; **Frank T. Weems,** SM '50, of Los Altos, Calif., died on October 15, 1989. No further information was provided.

XI URBAN STUDIES AND PLANNING

John K. Bullard, MCP '74, was re-elected to a third term as mayor of New Bedford, Mass. Major issues are the human costs of drug abuse and the dollar costs of building a secondary wastewater treatment plant to comply with the Federal Clean Water Act. . . . **Barbara Cole,** MCP '80, owns a firm that provides community and economic development services primarily in the western United States. She has been working with fellow MITers: **Andy Reamer,** PhD '87, in Boston, **Ric Richardson,** MCP '81, in Albuquerque, N.M., and **David Cooper,** MAR '80 (IV), in Denver, Colo. . . . **Lynne A. Monaco,** MCP '77, is an attorney in the Environmental Law Department at Nixon, Hargrave, Devans & Doyle in Rochester, N.Y. The firm specializes in air pollution and hazardous waste issues.

Tomasz Sudra, PhD '76, reports that as chief of the training unit of the United Nations Centre for Human Settlements (HABITAT), he is directing training activities of the organization. This includes training courses and workshops, high-level policy seminars, training of trainers, development of training materials and manuals, training need assessments, various forms of assistance to training institutions in developing countries, donor coordination, etc. Main subjects areas are: urban management, local government, housing, and infrastructure. His activities are mainly regional: in Anglophone Africa, Francophone Africa, Maghreb, Arab States, Latin America, South Asia and East Asia, some programs in Europe, but also for developing-country participants. His daughter Anna and son Macie have a new brother: Jon Jan, born in 1988. . . . **Alan Rabinowitz,** PhD '69, reports that since he resigned his professorship in urban planning at the University of Washington three years ago, he has been consulting and writing. The books that have emerged are *Land Investment and the Predevelopment Process* (Greenwood-Praeger Press, 1988), *Markets for New Construction 1980-87-95* (NPA Data Services, Inc., 1988), and *Social Change Philanthropy in America*, scheduled for publication in early 1989 by Greenwood-Praeger.

Henry G. Cisneros, '74, is a trustee of the Rockefeller Foundation. He continues as a director of Cisneros Group in San Antonio, Tex.

Cynthia E. Cohen, MCP '84, founder and immediate past director of the Oral History Center in Cambridge, Mass., spoke to the Manchester chapter of Hadassah last November at Temple Beth Sholom. Her topic was "A Passion for Life: Stories and Folk Art of Palestinian and Jewish Women." . . . **Robert C. Reeves,** SM '89, has joined the Houston office of Kenneth Leventhal & Co. as consulting manager. With seven years of tax and consulting experience, Reeves was most recently a manager with Ernst & Young in Houston where he specialized in corporate and financial planning for the banking and savings and loan industry.

Downtown, Inc.: How America Rebuilds Cities, (MIT Press), is a new book by **Bernard J. Frieden,** PhD '62, (IV) and **Lynne B. Sagalyn,** PhD '80. Both authors are in the Department of Urban Studies and Planning at the Institute. Frieden recently completed a term as Chair of the MIT Faculty and is the Ford Professor of Urban Development. Sagalyn is associate professor of planning and real estate development. The book, a progress report on our cities, "surveys the results to date [of several studies] to see if there is a real agenda for downtown in the mix of convention centers, malls, stadiums, hotels, and promotional events."

Brian W. Stoddard, MCP '87, died on September 21, 1989. He was a life-long resident of St. Mary's, Ga. Stoddard was a planner for the city of Jacksonville, Fla., and an accomplished pianist.

XII EARTH, ATMOSPHERIC, AND AND PLANETARY SCIENCES

Kristine Holderied, SM '88, is still on active duty as a lieutenant in the Navy. She is working at the Naval Eastern Oceanography Center in Norfolk, Va., as a meteorological/oceanographic forecaster for the North Atlantic. . . . **Danford G. Kelley,** PhD '59, retired from the Canadian Government Public Service after more than 35 years of service. He now consults for industry and governments on environmental management, air pollution, and solid waste management. . . . In January 1989, **David A. Cacchione,** PhD '70, became branch

BY VINCENT KIERNAN

Chaos in the Cosmos

Anyone who has wandered outside to look at the night sky—perhaps to see the full moon, or the Big Dipper, or Halley's comet—has relied on the notion that the cosmos behaves in regular, predictable ways. However, such confidence may be unfounded. Astronomers increasingly are finding ways in which the universe breaks out of fixed patterns.

So astronomers—like researchers in many other fields—are harnessing the new branch of mathematics known as chaos theory to find order in the unpredictable. One of the leaders in this movement is Jack Wisdom, an associate professor in Earth, Atmospheric and Planetary Science at MIT.

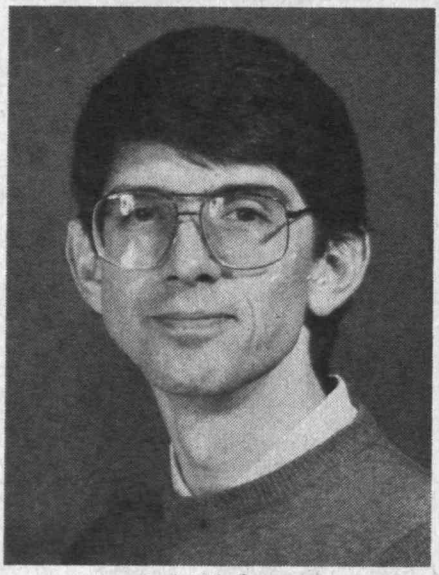
"Once you see that chaos is important, you can't look at things in the old way," Wisdom contends.

Chaos is one of the hottest topics in science today. Experts have been using new analytical tools to plumb chaotic phenomena as diverse as the beating of human hearts and fluctuations in wildlife populations.

Chaotic phenomena are inherently unpredictable. More powerful supercomputers or deeper understanding of the laws of physics won't make astronomical chaos any easier to anticipate; by definition, they are extremely sensitive to small disturbances of initial conditions. For example, two asteroids in chaotic orbits might start out in very similar orbits today, but the tiny difference in their orbits could put them on opposite sides of the solar system a million years from now.

While other astronomical theorists have been looking for chaos throughout the cosmos, Wisdom has concentrated on our own neighborhood, the solar system. Along the way, the soft-spoken, 36-year-old Texas native has transformed the way astronomers examine celestial processes.

Wisdom's first—colleagues say his most important—success concerns the meteorites that streak across our night sky. Astronomers long had thought that many of these meteorites had their origin in the asteroid belt, a zone of rubble between Mars and Jupiter. But they couldn't agree on how the rubble got kicked toward Earth or how to explain various gaps in the asteroid belt, although many suspected the gravitational influence of giant Jupiter.



Jack Wisdom

The asteroids, like the planets, orbit the sun in nearly perfect circles. But Wisdom found that after 100,000 years or more of unremarkable orbits, Jupiter's gravity suddenly—and unpredictably—would pull asteroids from a gap into very elliptical orbits.

Those elliptical orbits spell doom for the asteroids in them, Wisdom found, because they cause the asteroids to zoom inward enough to cross the orbit of Mars. Close encounters with the Red Planet, in turn, pull the asteroids into smaller, faster orbits—removing them from the gaps entirely and sending some of the asteroids on trajectories toward Earth.

Another chaotic phenomenon that Wisdom has been investigating is the rotation of Hyperion, one of Saturn's moons. The Earth and most other bodies in the solar system are more or less round. But not Hyperion: it's almost twice as long as it is wide. That weird shape, Wisdom and colleagues postulate, would subject Hyperion to a torque, or twisting force, from Saturn's gravity. As a result, they expect to find that Hyperion tumbles chaotically around Saturn, with both the direction and speed of its rotation constantly changing.

The U.S. space probe *Voyager* 2 photographed Hyperion when it flew past Saturn in 1981; the data are consistent with Wisdom's prediction of chaos, but inconclusive. Another Saturn probe now on NASA's drawing boards, called *Cassini*, may set the matter to rest once and for all, but many researchers believe Wisdom already. "It's pretty well accepted that the rotation is chaotic," said Peter Goldreich, who was Wisdom's doctoral thesis adviser at the California Institute of Technology. "It's sort of a curiosity."

One of Wisdom's latest contributions has been to address a long-standing question: is our solar system as a whole stable, or will it eventually fall apart? For centuries, many astronomers have assumed that the planets will continue to circle the sun in an orderly way; but there has been no rigorous mathematical proof.

Scientists who tried to resolve the issue by mathematically following the planets' orbits over millions of years reported that the planets continue to orbit predictably. But Wisdom's work with Gerald Jay Sussman, '68, professor of electrical engineering and computer science at MIT, leads to a more pessimistic conclusion.

They used a special-purpose computer, the Digital Orrery, which Sussman built while on a sabbatical at Caltech to test Wisdom's asteroid belt theory. On its own unique turf—orbital mechanics—the orrery operates at about one-third the speed of a Cray-1 supercomputer.

The duo ran the Orrery for five months straight, simulating the orbits of the outermost five planets for a much longer period than anyone had calculated previously—845 million years. They reported in the journal *Science* in July 1988 that Pluto's position can't be predicted more than 20 million years in the future. Furthermore, "when more than one Pluto was placed in the simulation at different starting points, they diverged at an exponential rather than a linear rate," they wrote. "That is characteristic of chaotic behavior."

Pluto's chaotic motion eventually will ripple through the orbits of other planets, triggering chaos throughout the solar system. That conclusion was confirmed in March of last year, when French researcher J. Laskar reported in the journal *Nature* that the four planets

PHOTO: NEWS OFFICE

closest to the Sun—including Earth—have chaotic orbits that are unpredictable beyond a few tens of millions of years.

"That doesn't mean that the Earth necessarily is going to do wild things," Wisdom said. "It does open up the possibility."

Sussman, who is developing a successor to the Orrery, says Wisdom is a class above most other practitioners of chaos theory because he makes specific, quantitative claims that are scientifically testable.

"He can tell you exactly what you can see in the solar system," Sussman said. "He's the smartest guy I know in that business."

Indeed, Wisdom is the only person ever to receive both the Helen B. Warner Prize, awarded by the American Astronomical Society to an outstanding young astronomer, and the Harold C. Urey Prize, awarded by the society's planetary science division to a young planetary scientist.

"He has turned everybody's ideas around on how to solve problems," said Stanton Peale, a physics professor at the University of California, Santa Barbara, who supervised Wisdom's postdoctoral research. "Many of us now are following his lead."

Wisdom seems pleased that he's convinced his scientific colleagues of the usefulness of chaos theory. "Now, people who don't know about chaos are working at a disadvantage. It's like being unable to integrate or use a computer," he said. Although he expects that he'll be doing something else in a few years, when chaos in the solar system is mined out as a research topic, he's not worried. "It's hard to imagine a problem where you wouldn't [consider] chaos as a possible solution."

Goldreich thinks that whatever topic his former student seizes next, Wisdom will make valuable contributions. "My guess is that he'll always do some offbeat type of work," Goldreich said. "He's quite a creative character, and that's not true of most scientists." □

Vincent Kiernan is the military space reporter for Space News *magazine. He was a 1988-89 Knight Fellow in Science Journalism at MIT.*

chief of Pacific Marine Geology at the U.S. Geological Survey in Menlo Park, Calif.

Ken Larner, PhD '70, reports that in May 1989, at a EAEG meeting in Berlin, he received the Conrad Schlumberger Award of the European Association of Exploration Geophysicists for "sustained and significant technical contributions and many papers over a number of years, services to the geophysical profession, and support of the EAEG." In August, 1989 Larner led an SEG delegation to a joint UCEG/SEF geophysical symposium and exhibition in Beijing, China. He received first prize for a paper presented at the symposium. In November, 1989 Larner completed a one-year term as president of the Society of Exploration Geophysicists. . . . **Steve Bratt,** PhD '85, just moved from San Diego to McLean, Va. to operate the Intelligent Monitoring System, a seismic monitoring network composed of stations on the Eurasion continent and an expert system (based in the Washington, D.C., area) to automatically detect, locate, and identify seismic events. He is at the Center for Seismic Studies and still works for Science Applications International Corp. He and his wife Amy have two children, Abby, 3, and Tony, 1, and were expecting their third when he wrote.

Alan T. Massey, SM '67, reports that he is a scout master with Boy Scout Troup 1 in Portsmouth, R.I. In July, 1989, he was a group leader for 11 scouts on a 90-mile mountainous trek for 10 days at Philmont Scout Reservation, Cimarron, N.M. Massey has been employed for 10 years with Science Applications International Corp., developing computer programs for oceanographic navigation and data acquisition. . . . **Leslie R. Martin, Jr.,** SM '47, writes, "I had a great visit last month from my MIT Graduate House roommate Jim Marstiller, SM '47, (XVI). Jim looks almost like he did 32 years ago and he still has that great sense of humor. Good luck in your retirement, Jim!"

William W. Hildreth, Jr., SM '53, retired as a research scientist from Lockheed Engineering and Management Co. in 1983. For the next six years, he was an instructor of meteorology and oceanography at the University of St. Thomas in Houston. Hildreth says he is "now available for consulting, forecasting, or more teaching!" He has served the city of Nassau Bay as a member of its council for the past seven years.

Lee-Lueng Fu, PhD '80, is a project scientist for the TOPEX/POSEIDON Mission, a U.S./France joint space mission mapping the surface currents of the global ocean with a radar orbiting the Earth on board a satellite. The results are expected to help unravel the ocean's role in the global climate system and improve prediction of phenomena such as El Nino and global warming. The mission is managed by the Jet Propulsion Laboratory of Caltech for NASA. . . . Rear Admiral **John R. Seesholtz,** PhD '68, retired from his position as oceanographer of the Navy and is now working in Arlington, Va., on oceanography and ASW (anti-submarine warfare) programs.

UNOCAL (Union 76) transferred **Steve Foster,** SM '73, his wife, and son from Los Angeles to the company's new office in Damascus, Syria. Foster is responsible for the acquisition, processing, and interpretation of geophysical data from the company's concession near the Turkish border. He reports "Syria is much nicer than most people realize and Americans are well liked here." This is his third overseas location, having previously lived in Norway and Argentina. . . . **David V. Fitterman,** PhD '75, has been with the U.S. Geological Survey for 15 years. His second child was born recently. . . .Since **Michael R. Nelson,** PhD '88, finished his degree, he's been working as a professional staff member on Capitol Hill. As the token scientist on the staff of the Senate Subcommittee on Science, Technology, and Space, he advices the senators on the subcommittee about global change, earthquakes, and a whole range of other science issues.

The Alumni/ae Association has been notified of the following deaths: **August E. Kunzelman,** '39, of White Plains, N.Y., died on March 5, 1989; **Arthur E. Buller,** '47, of Victoria, B.C., Canada, died on June 5, 1989; **Hans S. Buch,** S.M.'53, of Soborg, Denmark, died on January 12, 1989. No further information was provided.

XIII OCEAN ENGINEERING

Commander **William A. Dewey,** OCE '74, has been range operation department head at the Naval Undersea Weapons Engineering Station in Keyport, Wash., since September 1989.

Thomas R. Robinson, OCE '82, is a candidate for a PhD in engineering management at Old Dominion University in Norfolk, Va. Robinson is teaching senior-level engineering management courses under a teaching fellowship at Old Dominion.

A. Paul Amesse, NE '67, is vice-president of business development at International Computers & Telecommunications, Inc., in Rockville, Md. . . . Commander **Robert A. Ortmann,** OCE '76, is serving as commanding officer at Shore Intermediate Maintenance Activity (SIMA) in San Francisco. His command has been actively supplying post-earthquake repairs and ferry service while the Bay Bridge was being repaired. . . . Navy Lieutenant Commmander **Erik N. Christensen,** NE '89, has completed the Engineering Duty Officer School. During the six-week course, Christensen received training related to plans, programs, policies, and procedures used by the Navy throughout the lifecycle of its ships and systems.

John S. Heffron, NE '88, is head of the Quality Assurance Department at the U.S. Navy Supervisor of Shipbuilding in Groton, Conn. Heffron, his wife Liz and their daughters Sarah and Victoria were expecting Louise and **Mark J. Gray,** SM '87, as Christmas house guests. The Heffrons have spent some of their holidays with Carol and **David C. Johnson,** NE '89, at their new home in Connecticut.

XIV ECONOMICS

Peter Temin, PhD '64, professor and associate head of the MIT Economics Department, has written *Lessons from the Great Depression* (MIT Press, 1989). According to the book jacket it "provides an integrated view of the Depression, covering the experience in Britain, France, Germany, and the United States. It describes the causes of the Depression, why it was so widespread and prolonged, and what brought about eventual recovery."

Northwestern University President **Arnold R. Weber,** PhD '58, has been chosen to receive the Illinois Alumni Association's 1990 Alumni Achievement Award. Weber has directed two major universities. President at Northwestern since 1985, he led the University of Colorado for five years before that. He is considered to be one of the country's outstanding labor economists and is the author of eight books and monographs in the field. He has taught at many universities, including MIT. He has served in the public sector and is on several boards.

John A. Knauss, '46, under secretary for oceans and atmosphere and administrator of the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), took office August 7, 1989. A noted oceanographer and educator, Knauss was a professor of oceanography at the Graduate School of Oceanography at the Univerisity of Rhode Island (URI). He also served as dean of the URI Graduate School of Oceanography from 1962 to 1987, and as the university's provost for marine affairs from 1969 to 1982. Knauss has been a member of two presidential commissions on marine affairs: the Commission



J.A. Knauss



A.R. Weber

on Marine Science, Resources, and Engineering (the Stratton Commission) in 1967 to 1968 and the National Advisory Committee on Oceans and Atmosphere (NACOA), 1978-1985. He served as chair of NACOA from 1981-1985. He has been president of the Association of Sea Grant Program Institutions, chair of the Ocean Science Committee of the NAS/National Research Council, and chair of the Marine Division of the National Association of State Universities and Land-Grant Colleges.

Gilbert F. De Bartolo, PhD '76, of Bedford, Mass., died unexpectedly while playing basketball on October 19, 1989. From 1971 to 1976 he was an economist at Charles River Associates and from 1976 to 1983 an assistant professor of economics at Tufts University, where he specialized in econometrics, statistics, and economic theory. From 1983 until his death, DeBartolo was a software engineering manager at Intermetrics, where he took a lead role in the development of computer languages for use in the space program and automotive industry. He was an avid tennis player in town and he also coached children's basketball and helped out with Cub Scout activities. . . . **Robert B. Norris,** '42, of Storrs, Conn., died on May 13, 1989. No further information was provided.

XV MANAGEMENT

President Bush presented Robert R. Everett, SM '43 (VI),former president and CEO of the MITRE Corp., and **Jay Forrester,** SM '45 (VI), MIT professor Emeritus and School of Management senior lecturer, with the Medal of Technology, the nation's highest honor for technology. The honor is awarded annually by the president to recognize individuals or companies who have made exceptional contributions to the well-being of the nation through the development or application of technology. The joint award was presented to Everett and Forrester as managers of Project Whirlwind, which began in 1944 as an idea for a universal flight trainer and aircraft simulator. Developed at MIT for the Navy, it soon became much more: the first general-purpose, high-speed, real-time, parallel synchronous, electronic, digital computer. The award citation reads: "For their creative work in developing technologies and applying computers to real-time applications. Their important contributions proved vital to national and free-world defense and opened a new era of world business." . . . **Stephen A. Landon,** SM '68, reports that since July 1989 he has been working as CFO of Yegen Associates, a Paramus, N.J., financial services company. Yegen is a major originator of consumer loans. . . . **David S. Orlin,** SM '89, is working as production director for Gruner & Jahr USA Publishing in New York City. . . . **Jeffrey Mark Witzburg,** SM '74, is vice-president and co-founder of KenTech Systems located in Mansfield, Mass. The company provides products and services in support of IBM AS/400 computers and networks . . . **Michael J. Brennan,** PhD '70, is president of the American Finance Association. . . . **George E. McCord, III,** '62, spent the summer of 1989 in London consulting with the London Traded Options Market of the Stock Exchange on the development of a new automated stock-options market-data system.

Sharon (Tucker) Poole, SM '84, and **John Poole,** SM '84, are pleased to announce the arrival of Amanda Gordon on July 29, 1989. While on maternity leave, Sharon was promoted to product manager at Nabisco Brands. After a year and a half, the business John started selling AT&T phone systems has been "an outstanding success!," they write. . . . From Horseheads, N.Y., **John S. Lively,** SM '85, reports that he is a senior analyst in new business development at Corning, Inc. Lively is working on new optical components for fiber-optic distribution of cable TV. His first son, John Milford Lively, was born in November 1989. . . . **Allen C. Barbieri,** SM '87, writes "I been hangin' out. Had a baby girl...named her Sloan."

Edward J. Bartos, SM '78, is area director at Novell, Inc. . . . **Antonio T. Docal,** SM '85, is happy to announce that he was married to Terri Savin on July 9, 1989. A wonderful honeymoon was spent in Portugal and Spain . . . From Farmington Hills, Mich., **Daniel B. Beardslee,** SM '86, reports he was promoted to vice-president of Demery Seed Capital Fund. . . . After 35 years in nuclear power, **Thomas R. Moffette,** SM '54, has retired. He and his wife Ann are still in La Jolla, Calif. with four daughters nearby in San Diego. Moffette spoke with **John Davidson,** SM '54, while vacationing in England in May 1989. He encourages any classmates visiting in his area to call or drop in. . . . **R. Douglas Hulse,** SM '68, is president and CEO of SDTX Technologies, Inc.

Paul E. Appleby, SM '87, is an investment manager for Prudential Insurance Co. . . . From Wayland, Mass., **Cameron L. Smith,** SM '65, reports he has started as vice-president of Symmetrix, Inc., an industrial computer software and consulting firm. . . . **Marvin Campen,** SM '48, married Cynthia Brady in 1988 and the two of them had Kathleen Rebecca in 1989. . . . **Curt P. Kohlberg,** SM '82, joined The Boston Company Advisors as senior vice-president responsible for sales and marketing for the Investor Services Group. . . . **Bill Shaffer,** PhD '76, is happy to report that the company founded by him and his partner, Software Design Group, Inc., has been acquired by Science Applications International Corp. (SAIC). In operation since 1984, his company is a developer of custom software for the insurance industry. SAIC is employee-owned, with approximately $1 billion in revenue. He plans an early 1990 move to San Diego to take over responsibilities in SAIC's Comsystem Division in connection with the acquisition.

Burt Nanus, SM '59, published a new book on leadership in the United States. The book is called *The Leader's Edge* (Contemporary Books, 1989). This is Nanus' fifth book, and follows an 1985 bestseller called *Leaders: The Strategies for Taking Charge,* co-written with Warren Bennis, PhD '55 (XIV), which sold over 300,000 copies in the United States and has been translated into a dozen languages.

Paul E. Greenberg, SM '88, and Sloan Professor **Ernie R. Berndt** published their article "Canadian Energy Demand After the Oil Shocks" in *Petro Markets* (Fraser Institute, Vancouver, 1989). . . . **Warren Hoffman,** SM '63, was appointed principal consultant for DuPont Co.'s Information Systems Department in Wilmington, Del.



A.L. Frohman



E.A. Monrad

On October 1, 1989, **Kenneth P. Morrison,** SM '83, became a partner in the Chicago law firm of Kirkland & Ellis. On a recent deal, he worked with fellow Sloan graduate **Lonnie Essex,** SM '82, who "contributed to the leveraging of industrial America with a (well-deserved and very safe) LBO loan to his client." On the home front, Morrison and his wife Susan have their hands full with their bundle of energy, Jack. Any day now they are expecting him to test the random-walk-hypothesis. (Fortunately, he hasn't learned to throw darts at the financial pages or at anything else).

Steve Leichtman, SM '86, has joined the consulting staff of Temple, Barker and Sloane, Inc., as an associate specializing in areas of organizational effectiveness. He and his wife Gail are the proud parents of a son born in August 1988, Nathan Laurence. He causes them to wake up very early in the morning, but they love him very much anyway. . . . **David E. Labson,** SM '63 is living in Purchase, N.Y.

Charles Michael Iles, SM '85, reports that his interest in the management of entrepreneurial ventures, originally cultivated at Sloan, has led him to leave IBM and join ETS, Inc., a small high-technology firm specializing in state-of-the-art security systems. He holds the position of director of marketing, in which he is responsible for market strategy as well as sales force management. . . . **Raymond Forbes Weber,** SM '82, was promoted to senior vice-president and manager of the Project Investment & Advisory Division of Heller Financial, Inc., Chicago, Ill. He and his wife Gay had their first child, Scott Forbes Weber, on May 16, 1989. They are doing great!, they write. . . . **Curt P. Kohlberg,** SM '82, is senior vice-president and director of sales and marketing for the Boston Company Advisors (a subsidiary of Boston Co.). He maintains his position as president of Kohlberg & Co. where he is self-employed.

Robert W. Metz, SM '74, is now managing director of C.J. Lawrence, Morgan Grenfell, Inc., New York, N.Y. He was previously associate director of Bear Stearns & Co., Inc. . . . **Dennis B. Sullivan III,** SM '86, is manager of Canby, Maloney & Co. of Framingham, Mass. He was formerly with Greenberg, Rosenblatt, Kull & Bitsoli of Worcester as manager of finance and tax planning. . . . **Graham Copeland,** SM '89, has been appointed to the Lawrence, Mass., School Building Committee. Copeland, a general management consultant and registered architect (N.Y.) works for Temple, Barker and Sloane . . . Potomac, Md., resident **Alan Spoon,** '73, was named president of *Newsweek,* the weekly news magazine with a circulation of 3.2 million. Spoon has been CFO of The Washington Post Co. since July 1987.

Emery Olcott, SM '63, president of Canberra Industries, has been named the 1989 recipient of the MEDCO Keystone Award. The award was created in 1984 by the Meriden Economic Development Corp. to honor those who have contributed substantially to the economic growth of the Connecticut city and who have worked to improve the quality of life in Meriden.
His company employs 375 people and is the world's leading supplier of nuclear instrumentation. He has been on several boards and has donated generously to the YMCA. Olcott has also been a recipient of an "E" Certificate for Exports from then-President Reagan in honor of the company's outstanding contribution to the nation's Export Expansion program.

John R. Talbot, SM '62, is retired, but still active in R&D. He enjoyed visiting the Institute last summer, using the excellent library facilities, and taking in the local sights. . . . Frohman Assoc., management consultants of Lexington, Mass., and Arrowstreet, Inc., one of Boston's largest planning and architectural firms, have formed Corporate Resources, the first group to offer integrated management and architectural consulting to the business community. **Alan L. Frohman,** PhD '70, founder and president of Frohman

Assoc., will serve as chairman of the board of the new organization. . . . The MAC Group, an international general management consulting firm, promoted **Pierre M. Loewe,** SM '70, to senior vice-president. Loewe joined the firm in 1982 and specializes in strategy, organization, and marketing for multinational corporations.

Elizabeth A. Monrad, SM '80, has been named a partner in the Boston office of Coopers & Lybrand, an international accounting and consulting firm. Employed there since her graduation, Monrad specializes in providing audit services to clients in insurance, high technology, higher education, and nonprofit organizations. . . . **Cyrus R. Mehta,** PhD '73, Dana Farber Cancer Institute, Harvard School of Public Health; and **Nitin R. Patel,** PhD '73, Indian Institute of Management, Ahmedabad, India, have been awarded the 1989 George W. Snedecor Memorial Award for the best publication in biometry during 1988. The authors were awarded the honor for their paper "Exact Inference for Matched Case-Control Studies," *Biometrics* 44: 803-14. The prize is given annually by the American Statistical Assoc. and the Biometric Society, Eastern (ENAR) and Western North American (WNAR) regions, in memory of the Iowa state statistician George W. Snedecor, a pioneer in agricultural statistics and statistical design. . . . Vectron Laboratories President **Alfred I. Camhi,** SM '60, has committed his corporation to the sponsorship of the Norwalk (Conn.) Teaching Scholars program. For each of four years, a $5,000 donation will be made by Vectron Labs to send one minority high school graduate through a state university that features teacher preparation programs. The Scholar will pay back the award by teaching in the public schools for as many college years as were provided by the program. Vectron donates money to several other educational projects.

The Alumni/ae Association has been notified of the death of **Joseph J. Poli, Jr.,** SM '64, on July 29, 1989. Poli was residing in Ridgewood, N.J. at the time of his death. There was no further information provided.

Sloan Fellows

Mark A. Bailey, SM '88, has been made a vice-president of Indiana & Michigan Power, Fort Wayne, Ind. He was formerly executive assistant to the president at Ohio Power, Columbus, Ohio. Both are subsidiaries of the American Electric Co. . . . **Dale L. Compton,** SM '75, has been named director of NASA's Ames Research Center, Moffett Field, Calif. Compton had been acting director since July 15, 1989. As director, Compton will be responsible for all R & D programs and the overall management of the Ames Research Center and the Ames-Dryden Flight Research Facility at Edwards Air Force Base, Calif. Ames-Moffett and Ames-Dryden, which have more than 5,000 employees, conduct R&D programs in the fields of aeronautics, life science, space science, space technology, and flight research.

Norman F. Rohn, SM '56, of Camarillo, Calif., died on August 20, 1989. After retiring in 1981 as head of the fleet weapons engineering program at the Pacific Missile Test Center, Point Mugu, Rohn worked as a volunteer in Ventura County's Food Share program, gleaning surplus crops from the fields to be delivered to the needy. He was an active outdoorsman and an avid mountain climber, and was an instructor for the Sierra Club's mountaineering program. A longtime member of Sigma Xi, he was affiliated with many other societies and associations. . . . **Wesley M. Maulden,** SM '61, of Seattle, Wash. died on May 16, 1989. No further information was provided.

Senior Executives

Donald M. Roberts, '71, leaves the executive vice-presidency of U.S. Trust Corp., New York, N.Y. to become vice-chairman. He continues as treasurer. . . . **Leland C. McGraw,** '72, vice-president of finance at the Chevron Corp. in San Francisco, has been named a director at Carter Hawley Hale Stores, Inc., Los Angeles, Calif.

The Alumni/ae Association has been informed of the following deaths: **Harold O. Flynn,** '61, of Cadillac, Mich., died on December 20, 1988; **Bengt A. Samuelson,** '71, of San Mateo, Calif., died on September 12, 1988; **Joe T. Shelton,** '79, of Houston, Tex., died on October 8, 1989. There was no further information provided.

XVI AERONAUTICS AND ASTRONAUTICS

Commander **James W. Neighbours,** '41, is retired and doing a lot of traveling and participating in International Elderhostel programs. Neighbours is involved with many volunteer activities, including the MIT Educational Council. . . . Stationed at Wright-Patterson AFB, **Michael J. Aftosmis,** SM '89, is serving as a first lieutenant in the USAF. He is working in the Aero Lab on several projects. . . . **Henry F. Lloyd,** SM '46, is still in college administration at Flagler College in his hometown of St. Augustine, Florida. He served 30 years with the U.S. Navy. . . . **Clayton T. Crowe,** SM '57, has been elected a Fellow of ASME. He is a professor of mechanical engineering at Washington State University, Pullman, where he has been since 1969. He is renowned for his research and publications in two-phase fluid mechanics and numerical methods. His most significant contributions include the PSI Cell model for numerical modeling of gas-particle flows and techniques for measurement of two-phase flow using venturimeters. Crowe is the author or co-author of more than 50 technical publications, including the text *Engineering Fluid Mechanics.*

The Alumni/ae Association has received word about the following deaths: Captain **Robert B. Robinson,** SM '58, USN (Retired) of North Myrtle Beach, S.C., died on September 8, 1988; Commander **Robert F. Wadsworth,** SM '47, of Los Alamitos, Calif., died on November 17, 1988. . . . Brigadier General **Herbert J. Blaha,** SM '59, USMC of San Antonio, Tex., died on April 13, 1989. No further details were provided.

XVII POLITICAL SCIENCE

Jeffrey H. Boutwell, PhD '84, is the author of *The German Nuclear Dilemma,* which is scheduled to be published by Cornell University Press in early 1990. The book is a study of nuclear weapons policies of the two Germanies. . . . **Richard A. Rettig,** PhD '67, joined the Institute of Medicine professional staff (of the National Academy of Sciences) in January 1987, served as director of Council on Health Care Technology, 1987-88, and served as study director of the Study of Medicine End-Stage Renal Disease Program, 1988-present. . . . **Brian G. McCue,** SM '80, completed his book *U-Boats in the Bay of Biscay* (National Defense University Press). . . . To **Joseph L. Klesner,** PhD '88, a daughter named Emily, born on May 12, 1989. . . . **Peter M. Haas,** PhD '86, has written *Saving the Mediterranean: The Politics of International Environmental Cooperation.* It will be published by Columbia University Press and is scheduled to be available in April.

Lincoln P. Bloomfield, MIT professor of political science, has been appointed a director of the Canadian Institute for International Peace and Security. The purpose of the Institute, which reports annually to the Canadian parliament, "is to increase knowledge and understanding of the issues relating to international peace and security from a Canadian perspective, with particular emphasis on arms control, disarmament, defense and conflict resolution." The Institute was founded five years ago with the provision that two of its members be non-Canadian. . . . **Mary Fainsod Katzenstein,** PhD '75, is a professor at Cornell University. Before joining Cornell in 1973, she taught at the University of Massachusetts-Boston. She has been the recipient of numerous fellowships, including a Fulbright teaching assistantship in India and a grant from the American Institute of Indian studies. She is the author of *Ethnicity and Equality: the Shiv Sena Party and Preferential Policies.* . . . Brandeis Board of Trustees has approved **Hillard Pouncy,** PhD '81, as an associate professor with tenure. Pouncy is in the African and Afro-American studies program, and is affiliated with Brandeis' Florence Heller School of Advanced Studies in Social Welfare and its Gordon Public Center. He has written *Symbolic Politics: The Case of British Labor Policy in West Africa 1915-1945* and *Effective Transitions: A Job-Based Education Strategy for Raising the Earnings of Black Men.*

XVIII MATHEMATICS

Jan List Boal, PhD '59, writes that he and his wife are in their fourth year of operating a bed & breakfast inn, the Veranda, located 30 miles south of Atlanta's airport in a small town called Senoia. They are listed in the 1989-90 edition of *Country Inns and Back Roads* as well as other inn books. Boal will retire in June after thirty-six years of teaching—the last twenty-one years at Georgia State Univeristy in Atlanta. He has done some off-shore sailing during the past two years and hopes to do more after retiring. "I was 59 this past October, which is not only a prime and a twin prime, but also an irregular prime—one of three less than 100," he writes. . . . **Ralph W. Metcalfe,** PhD '74, has been appointed a professor in the Department of Mechanical Engineering at the University of Houston, Tex. . . . University of Wisconsin-Madison Professor **John A. Nohel,** PhD '53, is director of the Center for the Mathematical Sciences. He is thinking of retiring from the university system in 1991, but not from research. He writes, "My classmates who knew her will be saddened, if they don't already know, that my wife Vera died of cancer in May 1988, at age 61. Hard as it is, life does continue."

On July 1, 1989, **Richard M. Soland,** PhD '64, became chair of the Department of Operations Research at the George Washington University in Washington, D.C. . . . **Chris Bretherton,** PhD '85, writes he is now an associate professor at the University of Washington with a split appointment between applied mathematics and atmospheric science. He was awarded a PYI last year. Bretherton's research involves clouds, convection, climate, and fractals, with mountaineering interludes in Alaska and the Himalayas. . . . **Robert Eccles,** '73, has been granted tenure by Harvard Business School. An authority on complex organizations and management control systems, Eccles has been a member of Harvard's faculty since 1979. He has taught organizational behavior, business policy, and information management courses. Eccles' research focuses on the important management variables that contribute to organizational effectiveness. Based on extensive and in-depth comparative field research, his research projects require a strong interdisciplinary orientation. The first project of this nature was a study of transfer pricing that resulted in a book, *The Transfer Pricing Problem: A Theory of Practice.* His next project, a study of management in the investment banking industry, led to the publication of *Doing Deals: Investment Banks at Work.*

Allen L. Shields, PhD '52, of Ann Arbor, Mich., died on September 16, 1989. Professor of mathematics at the University of Michigan since 1956, Shields directed 26 PhD dissertations in his 33-year career, more than any other faculty member in the history of the department. He received the university's Distinguished Faculty Achievement Award in 1979. He was the author of a column in *The Mathematical Intelligencer* and published more than 90 articles in mathematical journals during his career. Shields worked primarily in the fields of measure theory, analytic func-

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Chris M. Erikson '85
Gretchen A. Young, '86
Christian de la Huerta, '87

tions, general functional analysis, and operator theory. "He had a vast store of knowledge and an amazing eagerness to discuss mathematics in any circumstances. He was a constant source of inspiration to students and faculty", noted a colleague. "Just a few days before his death, he was proofreading a paper he had written with a postdoctoral student. He was too weak to speak and could only point out errors, but he wanted to make sure it was completed before he died so the student could be published. That's the type of person he was," said the department chair.

XX APPLIED BIOLOGICAL SCIENCES

Dominick P. de Paola, PhD '74, is the president-elect of the American Association of Dental Schools. . . . **Arthur E. Humphrey,** SM '60, T.L. Diamond Professor of Chemical Engineering and director of the Center for Molecular Bioscience and Biotechnology at Lehigh University in Bethleham, Penn., has been named the 1990 vice-president of the American Institute of Chemical Engineers (AIChE). Humphrey has spent 37 years in academia. He served the University of Pennsylvania as head of chemical engineering and as dean of engineering and applied science. More recently, he served for six years as Lehigh University's provost and academic vice-president. He has held Fulbright Lectureships in biotechnology in a number of countries, including China, Japan, India, and Australia. Humphrey's achievements have earned him a number of awards from AIChE and election to the National Academy of Engineering. He has taken on a number of assignments for the Academy, as well as for the National Research Council and the National Science Foundation. In the latter capacity, he chaired the US/Japan Joint Committee on Biotechnology and the US/USSR Joint Committee on Industrial Microbiology.

XXII NUCLEAR ENGINEERING

Yehia F. Khalil, NUE '85, is a senior nuclear engineer in the Department of Reactor Engineering at Northeast Utilities in Hartford, Conn. His work activities include severe-accident analysis of light water nuclear reactors, thermalhydraulics and thermodynamics of nuclear power plants, nuclear reactor safety operations, and computer programming related to severe-accident scenarios. . . . **Walter H. d'Ardenne,** PhD '64, was the 1989 recipient of the Standards Committee Service Award of the American Nuclear Society. . . . **Joseph W. Johnson,** PhD '84, is a senior engineer in the Thermo-Magnetic Devices group at the Astronautics Corp. of America's Technology Center. . . . **David G. Adler,** SM '60, reports that he is manager of OEM Projects at Babcock & Wilcox in the Fossil Power Division, Barberton, Ohio. . . . In September, 1989, **Frederick A. Kautz II,** NUE '83, was elected to the office of director (one of three) of the New England section of the American Institute of Aeronautics and Astronautics (AIAA). He is a staff member in the Aerospace Engineering Group at Lincoln Laboratory.

In June, 1989, **Frederick H. Morse,** SM '59, left the U.S. Department of Energy, where he was office director of solar heat technologies, to open a consulting business called Frederick H. Morse & Associates, Inc. He offers consulting services and contract research in renewable energy technologies and related environmental and economic issues for utilities, industry, and government organizations. . . . **Stephen M. Goldberg,** SM '71, is the technical advisor for the Atomic Safety and Licensing Appeal Panel. . . . **Donald A. Dube,** PhD '80, has been promoted to supervisor of Probabilistic Risk Assessment at Northeast Utilities.

Frank J. Berte, PhD '71, has formed a new company called Tetra Engineering Group, Inc. They specialize in providing consulting and engineering services for the power industry. The services focus on reliability, statistical analyses, and preparation of engineering models.

After spending seven years with the U.S. nuclear industry, **Mankit R. Yeung,** ScD '78, joined the faculty of the University of Hong Kong in 1984. In addition to teaching undergraduate and graduate courses in heat transfer and nuclear engineering, he is conducting research in the areas of solar applications, PWR simulation, and accident consequences analysis for Hong Kong. Yeung is also a consultant to the U.S., Hong Kong, and Chinese utilities. . . . **Eduardo Testart,** SM '81, is head of the design section at the Fuels Fabrication Group at the Chilean Commission for Nuclear Energy. Recently, he was nominated executive editor of a new magazine *Innovacion*, edited under the auspices of the Chilean Society of Technology for the Development (SOTEC). Testart is actively involved in the area of technology transfer, technology innovation, and technology development. "Through the magazine, I will try to join the Chilean MIT community in order to strengthen the cooperation in our country as well as with the Institute," he writes. Testart and his wife, Ines, have two children, Eduardo Anares, 11, and Francisco Jose, 7. . . . **James K. Liming,** SM '83, of Fountain Valley, Calif., is a senior consultant with PLG, where he performs economic and safety-related risk analyses worldwide for a variety of industry and government organizations. . . . After spending many years living in Brazil and then Italy, **Eric Westberg,** SM '72, his wife Lucia, and their children, Kevin and Veronica, are living in Irvine, Calif. He is president of Hadson Power Co., which owns and operates alternate energy plants. . . . Captain **Michael R. Helmick,** SM '88, has been appointed assistant professor of mechanical engineering at West Point, where he has been teaching both thermodynamics and heat transfer. Helmick attended the ASME National Heat Transfer Conference last August on his way back from New Mexico where he was consulting for the Los Alamos National Labs on the national aerospace plane project. He was selected for promotion to major in the U.S. Army. Helmick and his wife, Gina, were expecting their first child in February as of this writing.

Chon-Kwo Tsai, PhD '85, writes "the best estimate methodology has been applied to LBLOCA (large break loss of coolant accident) analysis by Westinghouse Nuclear Safety Dept., where I am working. We have been given approval of 2-loop UPI (upper plenum injection) best estimate LOCA model by the NRC. This is a computer model established to evaluate core response to loss of coolant in an accident. The NRC has revised the Appendix K rules and we are now working on approval of 3-loop and 4-loop best estimate LOCA models." . . . **Sadik Kakac,** SM '60, professor of mechanical engineering at the University of Miami, has been elected the recipient of a Humboldt Research Award for Senior U.S. Scientists. "The award is given to honor highly qualified American scientists who have gained an international reputation in their field. The Alexander von Humboldt Foundation establishes a special committee of German scientists to review nominations which can only be submitted by German scientists. Significant research of international renown is the primary criterion," writes Kakac. . . . **Michael L. Gentry,** SM '66, technical director for the Army's Information Systems Engineering Command (ISEC), headquartered in Fort Huachuca, Ariz., was honored last fall for his expertise in distributed systems by the chair and board of directors of the Eighth Annual International Phoenix Conference on Computers and Communication. The conference is attended by academic, industry, and government representatives from the international community of engineers and scientists involved in R&D of information systems. Gentry was ISEC's representative at the three-day conference. While there he served as technical moderator for the Distributed Systems panel and was named best moderator by the attendees.

E. Rudge Allen, 1927-1990

Edward Rudge Allen, '48 a member of the MIT Corporation since 1987, died suddenly on January 5 in Houston. He was 62.

A native of Galveston, Allen received an SB degree in chemical engineering in 1948 and an SB in general engineering in 1949. He served as first lieutenant in the Air Force Reserve Air Research and Development Command from 1954-56, and was employed from 1949-1961 at Exxon Corp. in engineering, economics, and long-range planning. Allen joined Fayez-Sarofim & Co.of Houston in 1961, and at the time of his death was executive vice-president and director.

He served on the Alumni Fund Board from 1972-75, and was vice-president of the Association of MIT Alumni and Alumnae from 1983-86. He had served on the Corporation Development Committee (CDC) since 1973.

Memorial contributions may be made to MIT, the Children's Museum of Houston, and St. Martin's Episcopal Church of Houston. □

Deceased

The following deaths have been reported to the Alumni Association since the *Review* last went to press:

C. Lalor Burdick, '13; December 11, 1989; Wilmington, Del.
Harold S. Wilkins, '14; January 1990; Lancaster, N.H.
Frank J. Hull, '15; 1988; Jefferson, Ohio.
Richard Rimbach, '18; December 21, 1979; Pittsburgh, Penn.
Alan W. Burke, '20; December 7, 1989; Newton Centre, Mass.
Philip H. Hatch, '21; December 2, 1989; Erie, Penn.
Joseph W. Foster, '22; December 6, 1989; Melrose, Mass.
Mrs. Ralph R. Dresel, '23; December 1, 1988; Amity, Ore.
Roland P. Shugg, '23; 1989; Oakland, Calif.
Prescott H. Littlefield, '24; December 21, 1989; Naples, Fla.
George C. McFarland, '24; November 30, 1989; Haverford, Penn.
Ralph Frederick Gow, '25; January 16, 1990; Worcester, Mass.
G. Franklin Guilford, '25; June 6, 1989; Glastonbury, Conn.
George Kohfeldt, '25; December 6, 1989; Dallas, Tex.
Robert B. Morrissey, '26; November 30, 1989; Cape Neddick, Maine.
Nathan Pearlstein, '26; March 12, 1989; Hartford, Conn.
William M. Crane, Jr., '27; December 29, 1989; Medfield, Mass.
Harold E. Edgerton, '27; January 4, 1990; Cambridge, Mass.
Charles W. Newhall, Jr., '28; November 18, 1989; Del Ray Beach, Fla.
Kenneth M. Peterson, '28; October 30, 1989; Burbank, Calif.
Frederic A. Celler, '29; December 8, 1989; Maitland, Fla.
Putnam Cilley, '29; January 1, 1990; Sharon, Mass.
Sydney C. Hardwick, '29; June 10, 1989; Clearwater, Fla.
Frances M. Hendershot, '29; November 14, 1989; Westport Point, Mass.
Erling S. Mathiesen, '29; November 22, 1989; Milwaukee, Wisc.
Oliver K. Noji, '29; August 22, 1989; Menlo Park, Calif.
Robert K. Miller, '29; September 4, 1989; Allentown, Penn.
Robert Folsom Lent, '30; August 12, 1989; Houston, Tex.
William H. Locklin, '30; November 21, 1989; Guilderland, N.Y.
Charles R. Prichard, '30; January 7, 1990; Nashua, N.H.
William M. Wheildon, Jr., '30; December 9, 1989; Framingham, Mass.
Richard K. Baltzer, '31; December 3, 1989; Tallahassee, Fla.
Hymen Davis, '31; October 25, 1989; Glen Ridge, N.J.
Ruth Parsons Fuller, '31; December 15, 1989; York, Maine.
John R. Gardner, '31; January 8, 1990; Burnt Hills, N.Y.
Sydney R. Miller, '31; December 5, 1989; Dedham, Mass.
John H. Minnick, '31; December 20, 1989; Laconia, N.H.
Addison S. Ellis, '32; November 14, 1989.
Fred P. Feustel, '33; January 6, 1990; Fort Wayne, Ind.
Carl Rolle, '33; 1988; Laguna Beach, Calif.
Gordon C. Thompson, '33; December 31, 1986; Miami, Fla.
Robert W. Timbie, '33; February 16, 1989; Pensacola, Fla.
Angelo Iantosca, '34; December 9, 1989; Amherst, Mass.
Eric J. Isbister, '34; September 28, 1989.
Daniel C. Mitchell, '34; October 23, 1989; Sun City, Ariz.
W(averly) Quentin Smith, '34; December 1, 1989; Reston, Va.
E. Bennett Beede, '35; December 22, 1989; Concord, Mass.
Ernest C. Holtzworth, '36; May 15, 1989.
J. Irwin Wagner, '36; December 1988; Gorham, N.Y.
Norman K. White, '36; December 7, 1989; Newton Center, Mass.
Benjamin T. Woodruff, '36; November 3, 1989; Charleston, W.Va.
Edwin H. Place, Jr., '37; August 21, 1989; Marshfield, Mass.
Norris F. Dow, '39; March 28, 1989; Philadelphia, Penn.
Richard L. Steiner, '39; December 13, 1989; Baltimore, Md.
Alfred N. Ackerson, '40; December 16, 1989; N. Syracuse, N.Y.

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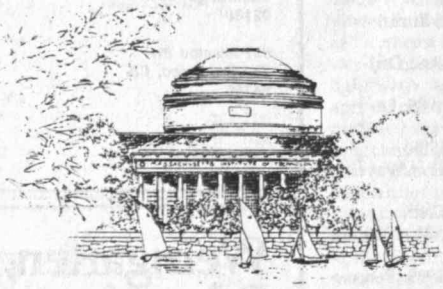
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Emily DeVoto
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Timothy L. Lash, B.S.'87
Stephen G. Zemba, S.M.'85, Ph.D.'89

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David E. Golan, M.D., Ph.D.

Edwin G. Brush, '40; June 12, 1989; Pacific Grove, Calif.
Charles W. Lindblom, '40; December 19, 1989; Granada Hills, Calif.
James M. Blackwood, '42; September 13, 1989; Bethlehem, Penn.
William Chepulis, '42; November 15, 1989; North Andover, Mass.
Julia C. Sullivan, '42; March 19, 1988; Boston, Mass.
Frederick F. McWilliams, '43; August 13, 1989; Boise, Idaho.
Stanley J. Pasternak, '44; November 1987; Portland, Maine.
B. Weber Luttenberger, Jr., '45; July 17, 1989; Lancaster, Penn.
Hugh A. Craigie, '46; December 16, 1989; Summit, N.J.
Israel M. Cramer, '47; November 18, 1989; Columbia, Md.
Robert A. Rapuano, '47; November 12, 1989; Marion, Mass.
Harry V. Madden, Jr., '49; December 3, 1989; Jamaica Plain, Mass.
John C. Miller, '49; August 12, 1989; North Easton, Mass.
Richard T. Daly, Jr., '50; November 17, 1989; Castine, Maine.
William D. Pinkham, Jr., '51; November 11, 1989; Short Hills, N.J.
Hugo Bosch, '52; March 15, 1989; The Hague, Netherlands.
Robert E. McCord, '52; August 29, 1989; State College, Penn.
Herbert M. Teager, '52; January 8, 1990; Belmont, Mass.
Herbert H. Anderson, '53; June 8, 1989; Naperville, Ill.
Donald A. White, '54; December 13, 1989; Westminster, Mass.
Harvey S. Hoshour, '55; December 27, 1988; Albuquerque, N.M.
Conklin C. Yung, '55; 1968.
Charles P. Lingle, Jr., '57; September 22, 1989; Bellflower, Calif.
Thomas J. Carroll, '58; July 23, 1989; Birmingham, Mich.
Robert B. Johnson, '59; December 12, 1989.
Clair A. Peterson, '61; June 12, 1988; Junction City, Calif.
Franklin P. Darmory, '64; December 7, 1989; Westfield, N.J.
Arnold F. Pyatt, '65; May 13, 1989.
B(enjamin) Frank Smith, '68; January 15, 1990; New York, N.Y.
Marvin G. Kirby, '72; December 19, 1989; Brookline, Mass.
Anthony C. Yeung, '73; January 1987.
Mrs. Samuel V. Chamberlain, 1988; Marblehead, Mass.



Where might a name best live?

The name of a deceased MIT alumna or alumnus can be linked to the Institute through gifts made by classmates, colleagues or family. Many donors ask that memorial gifts be unrestricted as to purpose. Contributions also can be made to cancer research, other programs in the life sciences or to any MIT fund. The Institute notifies bereaved families of the name of each donor.

Larger gifts can be used to establish a named endowment fund as a permanent memorial. If you would like information on ways of expressing sympathy through a memorial contribution, or on establishing a named endowment fund, please contact Betsy Millard, MIT Room E38-202, Cambridge, MA 02139 or call (617)253-8059.

ALLAN J. GOTTLIEB, '67

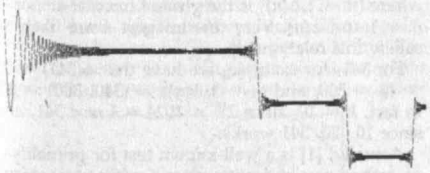
Milligram Cracker

It has been at least a year since I specified the size of the backlogs for the various kinds of problems that are printed. Let me do so now. We have about a year's supply of bridge, speed, and regular problems; about a half-year's backlog of computer-related problems; and as of today NO chess problems. Speedy Jim Landau (who just completed a master's degree in computer engineering; congratulations, Jim) reminds us that computer problems need not be straight programming assignments. For one example, see his **APR 1** below; for others consider computer architecture, finding bugs (hopefully cute ones) and figuring out what uncommented problems actually do.

I owe David Wagger an apology. He submitted two problems to *GSC NEWS*, a crossword puzzle and a cryptoquiz. The crossword puzzle was misprinted by *GSC NEWS* and the same incorrect version was reprinted in "Puzzle Corner". Even worse, the cryptoquiz, which was printed correctly in *GSC NEWS*, was mangled when reprinted in "Puzzle Corner" (a word was omitted and Wagger was misspelled).

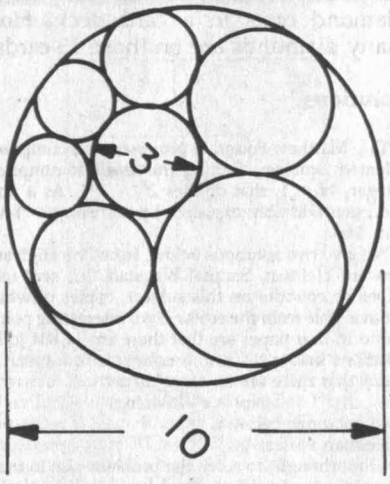
Problems

APR 1. We begin with a computer-oriented problem from Jim Landau, who wants you to write a program that generates (a reasonable facsimile of) the following graphic output.

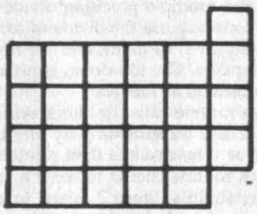


APR 2. Frank Rubin wants the largest prime having a digit that can be replaced by any of the nine other digits with the resulting number still prime.

APR 3. Matthew Fountain knows only that the inner and outer circles in the figure below have diameters of 3 and 10 but still wants you to determine the distance between their centers.



APR 4. The following problem appeared in "Golomb's Gambits" edited by Solomon Golomb in the *Johns Hopkins Magazine*. You are to divide the figure below into four congruent pieces. There are two solutions.



APR 5. Robert Bart's hypertension medication comes in 5 mg. tablets that can be divided in half to give morning and evening doses of 2.5 mg. each. At each dose, Bart selects a pill at random from the bottle. If it is 2.5 mg., it is used; if it is 5 mg., half is used and half returned to the bottle. Ignore size effects, i.e. the chance of getting a large pill is simply the percentage of pills that are large. Originally, Bart has N 5 mg. tablets and he wants to know what is likely to be the number of 5 mg. tablets remaining after i days. More specifically, he wants you to determine $P(n,N,i)$, the probability that n 5 mg. tablets remain after i days of use starting from N 5 mg. tablets and then determine the expected value



SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

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of n as a function of N and i, i.e.,

$$E_n(N,i) = \sum_n nP(n,N,i)$$

In particular, what is $P(1,N,N-1)$, the probability that the *last* two doses will be a single 5 mg. tablet rather than two 2.5 mg. pieces? If a closed form is not possible, how about numerical solutions for $P(50,100,50)$, $E_n(50,20)$, $E_n(50,40)$, $P(10,20,10)$, and $E_n(10,5)$.

Speed Department

SD 1. Mark Astolfi wants you to imagine that the National Football League abolished the 2-point safety. What scores (for one team) would become impossible?

SD 2. Eric Weill notes that there are 13 diamond *cards* in a card deck. How many diamonds are on those 13 cards?

Solutions

N/D 1. Matthew Fountain proposes, as a computer-oriented problem, finding the smallest nonprime integer, $N > 1$, that divides $2^{N-1} - 1$. As a non-computer addition, explain why there are so "few" such Ns.

We give two solutions below, from Bob High and Howard Helman. Samuel Wagstaff, Jr., sent us a paper he cowrote on this subject, copies of which are available from the editor. Two interesting points found in that paper are that there are 14,884 (odd) solutions below 10^{10} and a reference to a result of Erdos that there are no more than

$$x\exp(-c\sqrt{\ln x \ln\ln x})$$

such solutions below x.

Helman writes:

My first thought to solve the problem was to use a programming language which has infinite precision arithmetic. I had developed such a language modeled after TRAC and SAM76. After analyzing the problem, I noticed that it required two critical functions: 1) checking if a number is prime and 2) checking if a number evenly divides a number that in binary consists of a string of ones. If the solution is less than the size of a word on the computer, the prime check requires no multiple precision arithmetic and the multiple precision divide check can be simply done because the dividend consists of all ones (actually (n-1) of them) and we need only to check remainders. The top-down approach to solving the problem is as follows:

The main routine calls the check routine with n starting at 2 and incrementing by one until check returns a true. The result is then printed.

The check routine checks to see if n satisfies the problem constraints. Since 2 raised to any power minus one is odd, all divisors must be odd as well as nonprime. Therefore, check quickly rejects any even or prime n. For the remaining cases a number whose binary representation is (n-1) ones must be checked to see if it is evenly divisible by n. Assuming at least 16 bits in a machine word and a processor that can do 32-bit arithmetic, the process is the one one would use to divide a large number by a single digit divisor. Here we use 16-bit digits. The high order digit has (n-1) mod 16 ones in it and it is followed by (n-1)/16 digits of all ones. To generate the high order digit a shift is used to generate 2 to the x where x is (n-1) mod 16. Then subtract one to get x ones. At each step we only need the remainder (rem) from the previous step. Rem is shifted over 16 bits and the next digit (16 ones) is appended and the remainder is again computed. If the final remainder is zero, n divided our big string of ones, otherwise this n failed.

All that is left is a prime checking routine and prime(i) is a simpleminded one. Checks are made to see if i is even or is one of the primes 2 or 3. Otherwise i is divided by odd numbers less than the square root of i until all have been checked or a zero remainder is found. If no odd evenly divided i, i is prime.

The following C program incorporates the above design and it gave 341 as the first value. The program uses very little memory and yet $2^{340} - 1$ is 103 digits long.

```
#include <stdio.h>              /* C I/O definitions */
/* prime(i) returns 1 if and only if i is prime*/
int prime (int i)
 {int j, result;
  if(i < = 3)     result = 1;
   else if( !i%2) result = 0;
   else {
   j = 3;
    while(i%j&&j < i/j)
      j = j + 2;
    result = (i%j)! = 0;
  }
  return result;
 }

/*check(n) returns 1 if and only if n satisfies problem
requirements*/
int check(int n)
 {unsigned long rem,t;
  int i;
  if((n%2) = = 0 || prime(n)) rem = 1;
  else {
   t = (1 < < ((n - 1) % 16)) - 1;
   rem = (t - 1) % n;
   for (rem = t % n, i = (n - 1) / 16; i; i--)
    rem = (( rem < < 16) + 0xffffU) % n;
  }
  return (rem = = 0);
}

void main(void){int n;
 for (n = 2; !check(n); n + +);
  printf("the first is %d0,n);
}
```

Bob High's solution follows:

The smallest such number is 341. The following is a list of all such numbers under 10,000: 341, 561, 645, 1105, 1387, 1729, 1905, 2047, 2465, 2701, 2821, 3277, 4033, 4369, 4371, 4681, 5461, 6601, 7957, 8321, 8481, 8911.

If we have

$$2^{n-1} \equiv 1 \bmod n \qquad [1]$$

let k be the smallest integer such that

$$2^k \equiv 1 \bmod n$$

Then clearly we must have $k|n-1$, and k must divide the order of the multiplicative group of integers modulo n as well. This group has order $\phi(n)$, where ϕ is the Euler function, which counts the number of integers less than and relatively prime to n. We have that:

$$\phi(p^k) = (p-1)p^{k-1}$$

for p prime, and

$$\phi(mn) = \phi(m)\phi(n)$$

for m and n relatively prime.

This says that we must in fact have:

$$2^{(n-1,\phi(n))} \equiv 1 \bmod n \qquad [2]$$

where $(n-1,\phi(n))$ is the *greatest common divisor* of $n-1$ and $\phi(n)$. Very few integers n are likely to satisfy this relationship.

For 341, for example, we have that $\phi(341) = 30 \times 10 = 300$, and $(n-1,\phi(n)) = (340, 300) = 20$. In fact, $k = 10$, since $2^{10} = 1024 \equiv 1 \bmod 341$, and since $10 \mid 20$, 341 works.

Actually, [1] is a well-known test for primality—or, rather, non-primality, since if n *fails* to meet condition [1] it *must* be composite. Of course, the same test can be performed with other primes p in place of 2:

$$p^{n-1} \equiv 1 \bmod n \qquad [3]$$

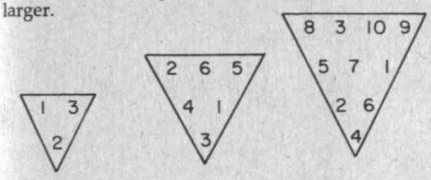
For example, for $p = 3$, we have the following values: 91, 121, 671, 703, 949, 1105, 1541, 1729, 1891, 2465, 2665, 2701, 2821, 3281, 3367, 3751, 4961, 5551, 6601, 7381, 8401, 8911, and for $p = 5$, we have: 217, 561, 781, 1541, 1729, 1891, 2821, 4123, 5461, 5611, 5731, 6601, 7449, 7813, 8029, 8911, 9881.

Note that the number 1729 is included in all three of these lists. This is *another* way in which 1729 is special (1729 is the number Ramanujan is supposed to have remarked upon to someone—Hardy?—on his deathbed, noting that it was "the smallest number that can be expressed as the sum of two cubes

in two distinct ways"). Since a prime must satisfy *all* such congruences, this provides a strong (but **not** infallible!) test for primality.

Also solved by Edwin Kruse, Robert Moeser, George Welti, Winslow Hartford, Richard Tooley, Harry Zaremba, Steven Feldman, Larry Bell, and the proposer.

N/D 2. Nob. Yoshigahara wants you to find the rule for each of the following triangular configurations of numbers and to produce a configuration one size larger.



The following solution is from first-time responder William Kampe:

The first trick is to figure out what the puzzle really requires. A quick look indicates the challenge is to fill a size five triangle with the integers 1, 2, 3, . . . 15 such that

a. The 5 is at the bottom apex.

b. For rows 2 thru 5 (starting at the top) each integer is the absolute difference of the two integers above.

A little thought shows that the 15 must be in the top row. Further, 12, 13, and 14 must be high up, with maybe a couple of the trio in the top row. After a little trial and error, I felt the number of combinations to try were too much for trial and error.

Then I thought about the different patterns of odds and evens that could lead to an odd at the bottom apex, and have the right number of 8 odd and 7 even numbers. A quick test of the possible arrangements of the top row yields only three valid arrangements of odds and evens in the top row (not counting mirror images):

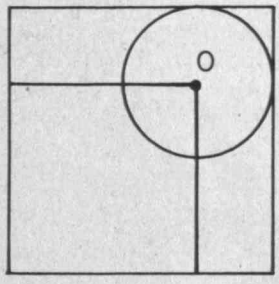
1.	2.	3.
o e o e e	o o o o e	o o o e e
o o o e	e e e o	e e o e
e e o	e e o	e o o
e o	e o	o e
o	o	o

A bit of trial and error here shows that there are actually very few combinations to test for each of the patterns, especially since 15 and the other high numbers must show up in the top two rows. As luck would have it, the solution came from pattern 3:

13 3 15 14 6
10 12 1 8
2 11 7
9 4
5

Also solved by Bob High, Harry Zaremba, Winslow Hartford, James Abbott, Mary Lindenberg, Allen Wiegner, Phyllis Grossberg, Alan Taylor, Larry Bell, Norman Spencer, Ken Rosato, Matthew Fountain, and the proposer.

N/D 3. Arthur Lewbel wants you to find the area of the small square without using Pythagoras's theorem. The area of the large square is one. The circle has center O, is tangent to two sides of the square, and passes through the center of the square.



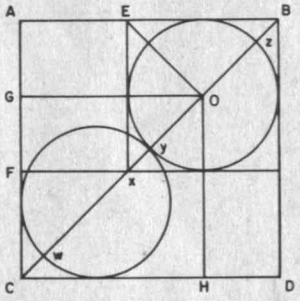
The following solution is from Tom Hansen (and son):

The area of the small square is 0.5, as the area of the small square is the same as the area outside the small square but within the large square.

To prove the answer, start with the figure shown in the question. Add a second circle with the same properties as the first circle, i.e. with the same radius (r), tangent to two sides of the large square, and passing through the center (Y). Draw a diagonal and add lines as shown on the enclosed figure, so that $\overline{BE} = \overline{AF} = 2r$ and $\overline{AG} = \overline{FG} = r$.

Look at the half of the large square defined by triangle ABC. Since the various angles involved are either 45° or 90°, it is easy to see that the area of region **AEOG** is equal to the area of region **FGOX**. Also, since $\overline{XY} = \overline{BZ} = \overline{CW}$, then $\overline{CX} = \overline{WY} = 2r$. Since $\overline{BE} = 2r$ as well, the areas of triangles BEO and CFX are equal. Therefore regions **ABOG** and **CGO** have equal areas. Similarly, regions **BDHO** and **CHO** also have the equal areas. The small square **CGOH** therefore has the same area as region **ABDHOG**, and since the area of the two regions together totals 1, the small square has area 0.5.

The same result can be obtained by trigonometry or by the proscribed theorem of Pythagoras. The correct result was also obtained by my ten-year-old son after 15 seconds of inspection, but he was just guessing. I think.



Also solved by James Cronander, Phelps Meaker, Winslow Hartford, James Abbott, John Morrison, Mary Lindenberg, Jules Sandock, Bob High, Harry Zaremba, William Kampe, Sidney Williams, Phyllis Grossberg, John McNear, Frederick Furland, Ken Rosato, Thomas Brendle, Larry Bell, Eugene Sard, Gordon Rice, Angel Silva, and the proposer.

N/D 4. Phelps Meaker wants to know the radius of a sphere circumscribing a regular tetrahedron.

Frederick Furland can help out Mr. Meaker:

As opposed to N/D 3, this problem can be solved inter alia through repetitions of Pythagoras's theorem.

The line through the center and perpendicular to the equilateral triangle forming the base of the regular tetrahedron is the locus of the center of all spheres whose surfaces touch the three vertices of that triangle. At one point on that line the surface of the sphere also touches the vertex of the tetrahedron. That is the sphere that we seek.

Figure 1. shows the base triangle, ABE of the tetrahedron. We find C, the center of the triangle as follows:

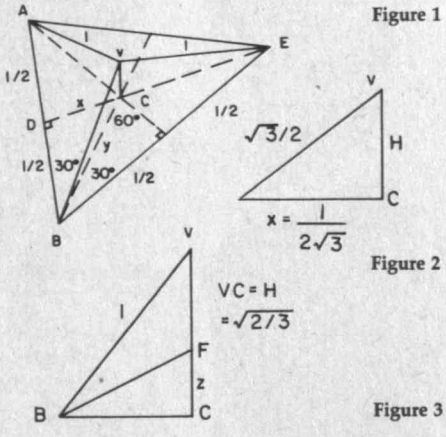


Figure 1

Figure 2

Figure 3

Each side of the triangle is of length 1. The three angle bisectors are perpendicular to the opposite sides and meet at the center of the triangle, C. Using the auxiliary 30° − 60° − 90° triangles shown in Figure 1, we find $x = 1/(2 \cdot 3^{0.5})$, $y = 1/3^{0.5}$.

Now, using one of the equilateral triangle sides of the tetrahedron, ABV, we can find the height of the tetrahedron, CV, from Figure 2. to be $H = (2/3^{0.5})$.

Using Figure 3, we see that the desired radius is BF = VF. Letting CF = z, we have

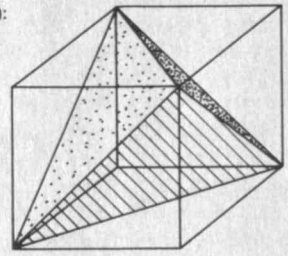
$BF = [z^2 + (1/3^{0.5})^2]^{0.5} = VF = (2/3)^{0.5} - z$

Solving $z = 1/6\ (3/2)^{0.5}$. Thus, the radius of the sphere

$r = (2/3)^{0.5} - 1/6\ (3/2)^{0.5} = 0.612+$ times the length of a side of the tetrahedron.

A different technique was employed by Geoffrey Landis, who writes:

I don't usually respond to Puzzle, but problem N/D 4 has such an elegant geometrical solution that I felt compelled. The solution comes from constructing a cube by placing a plane onto each of the six edges of the tetrahedron (or equivalently, viewing the tetrahedron as a cube with four of the corners cut off):



Clearly, the circumscribing sphere is the same for both the cube and the tetrahedron, and has a diameter $\sqrt{3}$ times the edge length of the cube. Since the tetrahedron has an edge length $\sqrt{2}$ times the edge length of the cube, if the tetrahedron edge length is defined as "t" the radius of the sphere must be $(\sqrt{3}/2)/\sqrt{2})t = \sqrt{6}/4\ t$.

Also solved by Jules Sandock, Robert Moeser, Avi Ornstein, Winslow Hartford, Bob High, Harry Zaremba, Steven Feldman, Ken Rosato (who thinks we may have asked this question before), David Wagger, Jim Landau, Daniel Morgan, Larry Bell, and the proposer.

N/D 5. Our final regular problem is from Gordon Rice who notes that, by successive flips of a coin, we may generate a random number between 0 and $2^N - 1$. Each flip determines one digit in the binary representation of the number; heads it's a one, tails it's a zero. Suppose we have a biased coin, which comes up heads with probability P. What is the expected value of an N-bit number generated with such a coin?

The key point is to notice, as did Steven Feldman, that the individual bits are independent so the expected value can be computed as the sum of the expected values due to each bit. Hence the answer is

$1P + 2P + 4P + \ldots + (2^{N-1})P = (2^N - 1)P$

Also solved by Geoffrey Landis, Bob High, Alan Taylor, Allen Wiegner, Daniel Morgan, Larry Bell, Winslow Hartford, and the proposer.

Better Late Than Never

1989 JUL 2. Larry Bell has responded.

JUL 3. Larry Bell has responded.

N/D SD1. Jim Landau points out that the author is really Greg DeStefano and Edwin Kruse points out that the year 2000 won't be as bad as predicted.

Proposers' Solutions to Speed Problems

SD 1. 2, 4, 5, 8, and 11.

SD 2. 81. Each of the 13 cards has a diamond in the upper left corner and one in the lower right corner, for a total of 26. The face cards have no other diamonds on them. The ace through 10 have 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 = triangular 10 = 55 diamonds. 55 + 26 = 81.

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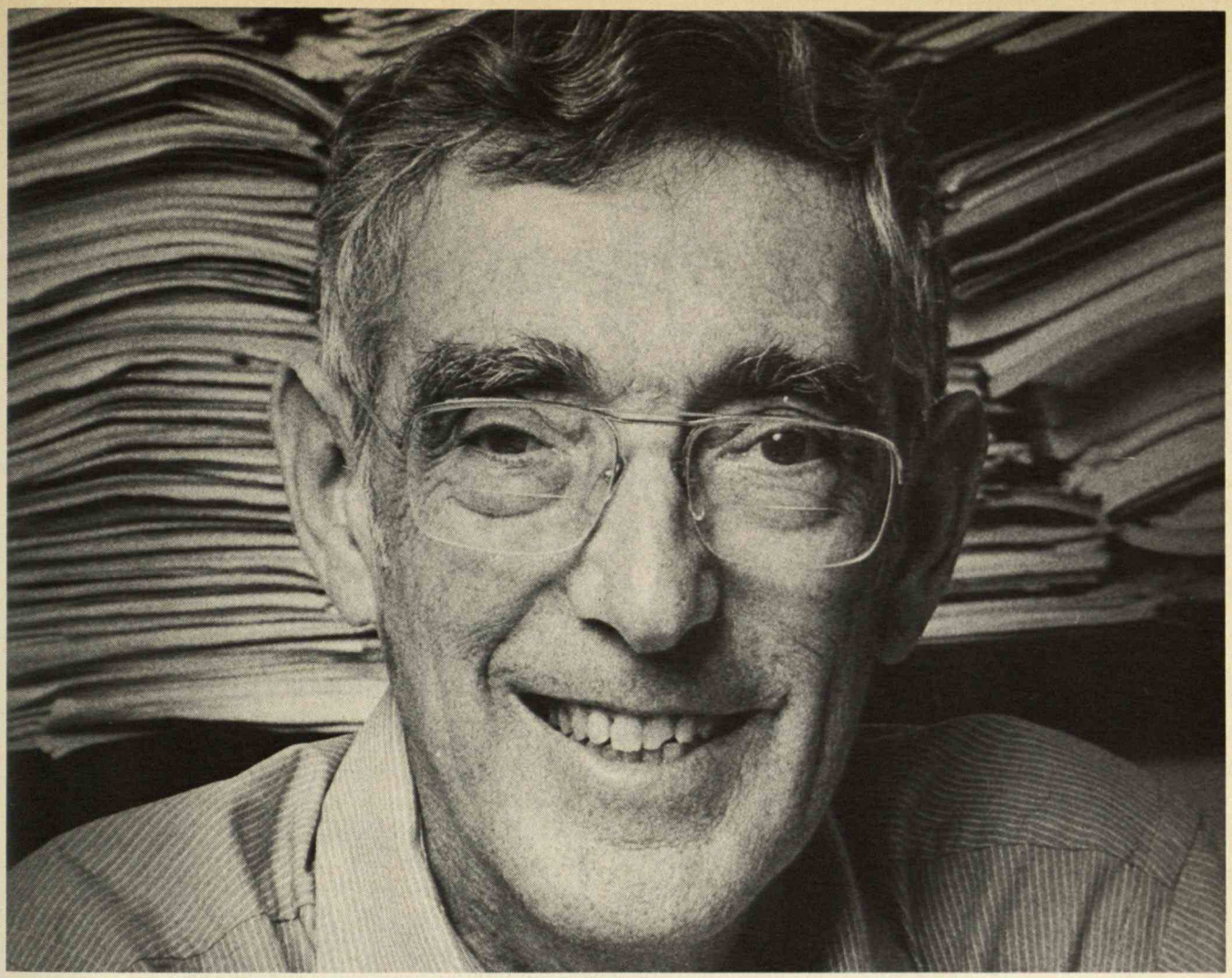
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Radical reform in an Indian state indicates that economic growth is not a prerequisite for progress.

WHILE most Third World countries seek to advance primarily through boosting production and investing in expensive technology, the state of Kerala in southwest India has chosen a radical alternative—economic redistribution. And although the region suffers from overwhelming poverty and is one of the most densely populated on the face of the earth, it has achieved some of the Third World's highest scores on important indicators of development.

The life expectancy in Kerala—68 years—is closer to the U.S. average of 75 years than to India's 57 years or the abysmally low 52 years in a World Bank sample of low-income countries. Kerala's infant mortality rate is 27 per 1,000 births, compared with 106 for low-income countries and 86 for India. The birth rate, at 22 per 1,000, is only a little worse than the U.S. rate of 16; the figures are 43 for low-income countries and 32 for India. Almost three-quarters of Keralites can read or write; fewer than half are literate in the rest of India (*see the table on page 45*).

These indicators are especially important because they say much about the distribution of social and economic gains. If wealth is highly concentrated, per capita income can be high while most people have little. But literacy rates improve only when a great number of people learn to read and write. The average life span rises minimally if only the elite live longer. Infant mortality and birth rates change little unless medical care is widespread.

Just as striking, Kerala's quality of life benefits are fairly evenly distributed among men and women, urban and rural areas, and low and high castes (*see the table on page 48*). Male literacy, for example, is just 9 points higher than that of females, while the differ-

BY RICHARD FRANKE AND BARBARA CHASIN

PHOTOS: RICHARD FRANKE AND BARBARA CHASIN



In Kerala, India, land redistribution, education, and health and food programs have made for remarkable gains in life expectancy and literacy, even though growth has been slow and unemployment high.



ence is 22 points for India as a whole. Urban areas are nearly twice as literate as rural ones throughout India, while in Kerala the disparity is slight. For both infant mortality and birth rates, rural Kerala is only slightly behind cities.

The results of studies Indian agencies have conducted on productivity and basic services are similarly impressive. The state is first on 15 of 20 measures of basic services—roads, post offices, and schools—and ranks very high on five others (*see the table on page 49*).

Kerala's achievements are most meaningful to the people of Kerala, but the data also have implications for economic development elsewhere. In every developing nation, the many possible paths boil down to a single issue: which is more effective, growth or redistribution? Governments can strive to generate more output by stimulating capitalist enterprise. Higher income levels generally do produce longer life, more education, and fewer infant deaths. Alternatively, governments can dampen growth by redistributing wealth, then sponsor some form of investment. For any given average per capita income, even in high-income countries, redistribution provides substantially better education, longer life, and lower infant mortality than does growth alone.

In practice, the two paths to development are usually incompatible. Only Taiwan and the two Koreas have recorded both growth and redistribution. Many nations—including most in Latin America, the Middle East, and Southeast Asia—have grown considerably, at least before the 1980s, but with little redistribution. Some of the world's least developed countries have failed on both counts. Among the few cases of redistribution with little growth are China and Cuba, which have had revolutions. Only Tanzania, Sri Lanka, and the state of Kerala have chosen redistribution while remaining in the capitalist economic system.

Thus, while this small coastal strip contains just 27 million people and 1 percent of India's land, Kerala is more than a tiny exotic subtropical detail in the world's second most populous country. Rather, the region represents an experiment in radical reform as a modern development strategy. Kerala's remarkably high levels of health, education, and social justice follow directly from decades of political struggles.

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QUALITY OF LIFE INDICATORS (1979–80)	KERALA	INDIA	LOW-INCOME COUNTRIES	UNITED STATES
Per capita GNP (in $)	182	290	200	17,480
Adult literacy rate (%)	78	43	NA	96
Life expectancy (in years)	68	57	52	75
Infant mortality (per 1,000)	27	86	106	10
Birth rate (per 1,000)	22	32	43	16

Kerala's 1969 land reform, in which 1.5 million tenants received full title to the land they worked, has been one of the most successful in the Third World. Inset: The state government also built 57,000 houses in the 1970s, each with a hard foundation and a tile roof.

Ecology, Geography, and a History of Struggle

Kerala's achievements rest on a number of factors. For example, its rather even distribution of rich resources has helped foster a similarly even pattern of settlement, which has simplified the delivery of health and educational services.

Kerala has long been a major international trading center. The region is thought to have exchanged cardamom and cinnamon with Babylonia as early as 3000 B.C. In more modern history, plantations and other capitalist enterprises sprang up under British rule, and a working class was created. These developments combined with the ancient cosmopolitan traditions to establish conditions for radical organizing. Thus, twentieth-century Kerala witnessed significant movements of peasants, workers, and low-caste people who wanted more than formal independence from the British empire. They saw in independence a promise of better income and expanded democratic rights.

In Kerala, such movements were far larger than in most of India. Although other states, such as West Bengal and Tripura, have also elected communist governments in recent years, Kerala's progressivism is firmly entrenched. In 1957, voters of the newly formed state of Kerala elected the first communist majority to the state legislature. Since then, Kerala's voters have elected three solidly leftist governments, and a left-right coalition that ruled through the 1970s carried out many policies of its left predecessor.

In fact, movements of workers and small farmers in Kerala have persevered for the most part throughout the past 80 years. They have produced and sustained leaders from all the major castes and religions. As recently as 1988, 750,000 people joined popular actions in Kerala's communist heartland of Alleppey.

The radical organizations of the region compete for members and influence but generally agree on the basic need to make poor people the main beneficiaries of development. And despite the many twists and turns of party coalitions and governments, these groups provide the constant element in Kerala's political culture. With leftist governments in power, major laws have been passed to redistribute income and income-producing assets such as land. But even when conservative governments have held sway, Kerala's workers and peasants have won reforms. The reason is that the left parties, unlike U.S. parties, are made up of highly organized peasant associations and labor unions, which agitate for change no matter who holds formal state power.

Land to the Tiller

The distribution of landownership is a major factor in the persistent poverty of most underdeveloped countries. Without land reform, little else can change. Most Third World countries have carried out some type of land reform, but the rich have often benefited more than the poor. By contrast, Kerala's 1969 land reform is one of the most thorough and successful in the Third World. Some 1.5 million tenants received full title to rice fields they worked, house-compound land, or both.

In Kerala, no issue provoked people's passions as did land tenancy. The reason is simple: through landownership, the rich and powerful had maintained control. Land was a resource to which the poor looked as their lives deteriorated, often to the point of starvation.

Just before the 1969 act, 8.1 percent of landowning households controlled 44.4 percent of all rented land and 61.8 percent of irrigated rental lands. Landholding inequality among farming households was the third worst in India.

"Inferior" tenants (*verumpattamdar*), who were the actual cultivators, were in the most difficult position. Despite some British and state legislation to protect them, their leases could usually be terminated by a class of superior tenants (*kanamdar*) or by the actual landowners (*janmies*) above them. Because of this insecurity, the *verumpattamdar* could be compelled to pay exorbitant rents. A study from Cochin in the 1940s

found that cultivator households paid at least 50 percent and sometimes over 75 percent of their gross returns to the classes above them.

The same *janmies* owned the small plots of land on which tenants and farm laborers built their own houses and grew bananas, coconuts, cashews, mangoes, cassava, and other crops to feed themselves. The threat of eviction from such lands was a powerful weapon.

Frequent rebellions broke out against tenancy. From 1836 to 1853, for example, more than 20 uprisings occurred in Malabar, now northern Kerala. Mostly Muslim tenants attacked mostly high-caste Hindu landlords. Some 10,000 people died in the Mapilla—or Muslim—rebellion in 1921, but the 1930 law that resulted achieved nothing for the poorest tenants.

The turning point came in 1957, when the new state of Kerala elected a communist majority to the state legislature. The government included cabinet members who were themselves seasoned militants of peasant and worker movements, and their electoral charge included radical land reform. They set out to meet this charge, but landlords organized demonstrations and appealed to the central government to dismiss the communists. Although Kerala did enact laws to relieve tenants, the state government was indeed dismissed two years later, delaying or undermining effective land reform. Kerala entered a period of political instability, with recurrent presidential rule from New Delhi.

In the late 1960s, tenants took matters into their own hands, planting red flags on their tenancies and claiming the right to farm the land without paying rent. Pressure became so great that most politicians, including India's then ruling Congress Party, supported land reform, and a comprehensive program, although weaker than that of 1959, became law in 1969.

Two components of this reform appear to have been ineffective: a ceiling on the size of landholdings, and a rice levy on the largest landowners that was to be collected by the government and redistributed to peasants and farm laborers. However, tenancy reforms have massively redistributed land rights—and, therefore, power.

Abolishing both household and field tenancy transformed landlords—mostly high-caste Brahmin priests—into teachers, government administrators, and mid-sized farmers. Although some have suffered, most now contribute to the development of Kerala's economy. In any case, the reform compensated landlords. For rice fields, they received 16 times one year's fair rent, as determined by a government committee. The compensation for house-compound land was 25 percent of market value, with half paid from a government land-purchase trust and half by the former tenant.

At the other end, however, many new small landowners have suffered from the declining price of rice relative to other products. They often lack the necessary capital to plant more lucrative crops, such as coconuts or rubber. Consequently, the direct economic benefits of the land reform have been less than hoped for, illustrating the difficulties of transforming a feudal system into small-farmer private production when incomes stagnate and agricultural prices are unpredictable.

Nevertheless, land reform has improved the vast majority of lives in Kerala's countryside. For tenants who received rice paddies, the land is usually the source of at least half their basic food needs. Now there is no rent to pay and no fear of eviction. Life—while below any reasonable standard for the modern world—has advanced greatly within a single generation.

Food for All

Of all the needs in the poorest countries, food is surely the most basic, a prerequisite to health and long life. Nutrition in Kerala is at least equal to and perhaps slightly better than that of the rest of India, despite the state's much lower per capita income. While it is difficult to analyze actual caloric intake, measurements the Indian Council of Medical Research has collected on the growth of children suggest that Kerala's people are well fed in the Indian context. Yet Kerala's children remain far below international standards in height and weight.

Food in Kerala is widely available at controlled prices through school lunch programs, feeding programs at nurseries for infants and pregnant and lactating women, and "ration shops." Public distribution of food via these shops is Kerala's most extensive mechanism for insuring adequate nutrition. Nearly all Kerala households receive ration cards that allow them to buy rice, cooking oil, and other basic commodities at subsidized prices, with the amounts of each determined by how much land they own. Some stores are cooperatives, but most are private businesses that receive a fixed profit. All goods are also available on the parallel private market.

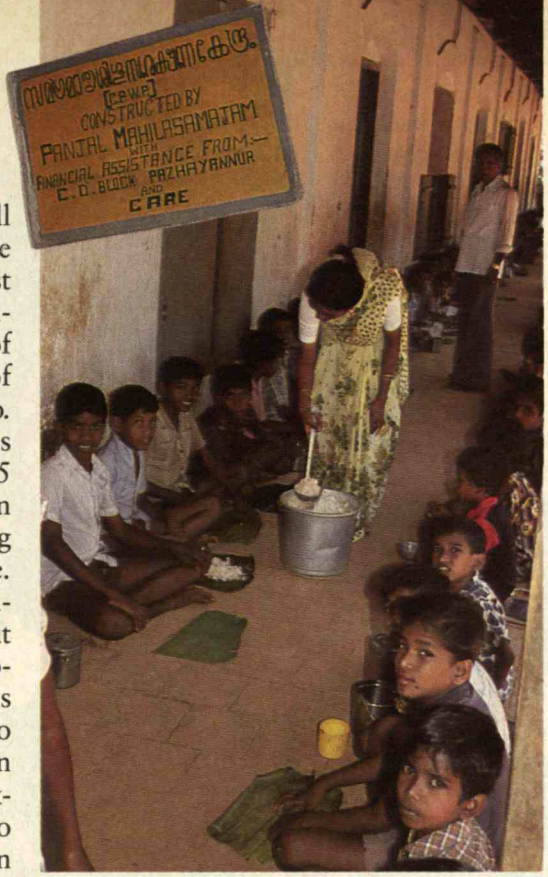
Established in Kerala during the First World War, ration shops came to serve large numbers of people only after India's 1964 food shortages. At that time, Kerala's government purchased rice and wheat to ensure that enough was available. Since then, Kerala's shops have been the most effective in India, with at least one located within two kilometers of 99 percent of Kerala's villages. In contrast, only 35 percent of the villages in India as a whole have a shop so close by. By 1988, almost 13,000 ration shops accounted for about 15 percent of total calorie intake and 20 percent of total protein intake in Kerala.

School feeding programs in the southern Kerala districts of Travancore and Cochin started in the 1940s.

Expanding those programs to all students was proposed in the late 1950s during the first communist ministry. The proposal was realized in 1961 with the assistance of CARE, which provided most of the food until just a few years ago. Now the state government funds the programs, which fed about 75 percent of students aged six to ten by the early 1970s; the remaining 25 percent probably ate at home.

By 1987, over 2 million children received daily meals of about 410 calories and 15 grams of protein. Until that year, the programs offered a daily hot lunch just to students in grades one to four. In June, the new leftist coalition expanded coverage to grades five to seven—reaching 3 million children.

Many Kerala women and their infants receive a free meal each day at village nurseries that women's associations run with government funds. In the early 1970s, these centers fed more than 150,000 women and infants daily. In 1988, 9,227 feeding centers served 265,000 women and infants.



Noonday lunches nourish 3 million schoolchildren. Originally funded by CARE, the program now receives all its support from the state government.

The Right to Health

After food, perhaps nothing is more crucial to life and welfare than health. In Kerala, health care is a right. Ordinary people have struggled for it. They expect it. They continue to struggle to maintain, expand, and improve it.

Kerala's children show the most dramatic benefits from health programs. The infant-mortality rate is very low, and children under five fare much better than in the rest of India. From 1968 to 1970, the latest year for which an appropriate comparison is available, Kerala recorded only 24 deaths per 1,000 children under five, far better than any other Indian state or the Indian average of 62. UNICEF has suggested that this measure is the single most informative indicator of development.

Kerala has vastly improved health through better housing, sanitation, water, and immunization programs. Also, health-care facilities are better funded and staffed and more accessible than in the rest of India.

Poor housing can be a major source of disease. Dirt floors and palm roofs attract bacteria and mosquitoes. Overcrowding exacerbates the spread of infections and parasites. After the 1971 Indian census found that 20 to 25 percent of housing in Kerala was unfit for habitation, the state adopted and expanded a national homebuilding program for landless laborers.

Financed by state and central-government revenues, the Kerala plan is known as the One Lakh Houses Scheme, after the Indian word for 100,000. In each of Kerala's 960 villages, 100 houses were to be built, for a total of 96,000 units. Although the plan cost far more than envisioned, 57,000 houses were constructed by 1978. Each house has 250 square feet of floor space, three rooms, a hard foundation, a cement floor, sun-dried brick walls, and a tile roof on hardwood beams taken from the state's forests. The houses of several tens of thousands of low-income families were built or improved under supplementary state programs.

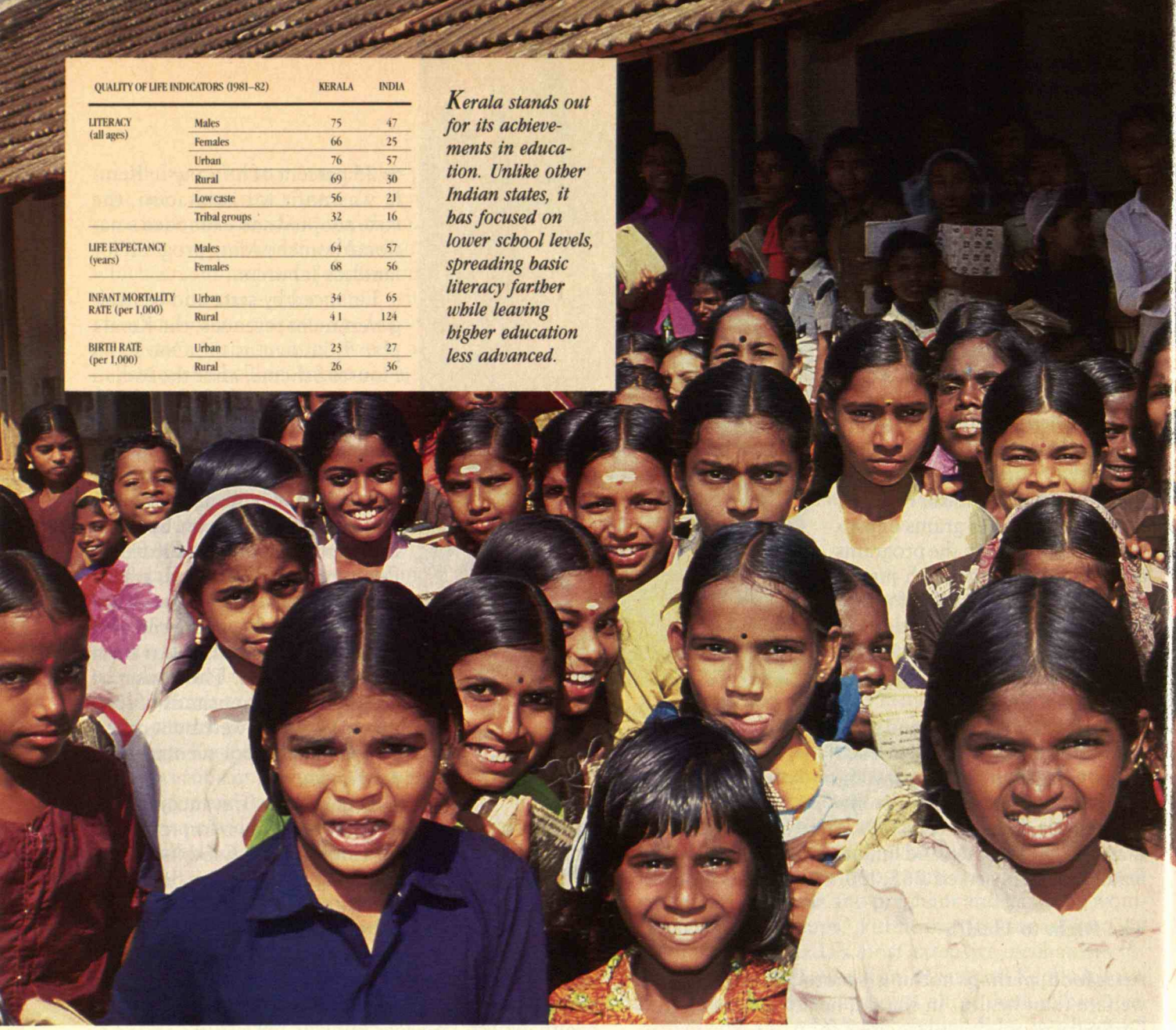
Beginning in Travancore in the late 1800s, government-sponsored Town Improvement Committees and Rural Conservancy Establishments took on the task of improving sanitation. They disinfected wells and water tanks, removed feces from roads, graveled the roads, and supervised health conditions at markets and religious festivals. They also set construction of safe latrines as a goal, but progress has been slow. Many rural families still use open-air sites, and health experts consider budgets for latrines and sewage insufficient to meet Kerala's ambitious 1990 target of safe waste disposal in 80 to 100 percent of urban areas and 25 percent of rural areas. By 1985, only 28 percent of urban areas and 2 percent of villages had full operational sanitation facilities; the Indian rates were 28 percent for urban areas and less than 1 percent for rural areas.

Safe drinking water is probably the best way to curb the spread of parasites and infections. In Kerala in 1980 and 1981, 29 percent of rural people and 72 percent of urban dwellers had potable water. By 1985 the rural figure had risen to 41 percent, and by 1988, 82 percent of the city dwellers had protected water. Nevertheless, Kerala doesn't stand out among Indian states, and gastrointestinal infections that cause diarrhea remain a hurdle. At the same time, only 1 percent of villages have serious water problems, among the lowest incidence in India.

Preventive immunization and vaccination are Kera-

QUALITY OF LIFE INDICATORS (1981–82)		KERALA	INDIA
LITERACY (all ages)	Males	75	47
	Females	66	25
	Urban	76	57
	Rural	69	30
	Low caste	56	21
	Tribal groups	32	16
LIFE EXPECTANCY (years)	Males	64	57
	Females	68	56
INFANT MORTALITY RATE (per 1,000)	Urban	34	65
	Rural	41	124
BIRTH RATE (per 1,000)	Urban	23	27
	Rural	26	36

Kerala stands out for its achievements in education. Unlike other Indian states, it has focused on lower school levels, spreading basic literacy farther while leaving higher education less advanced.



la's most impressive public-health projects. Smallpox vaccination in Travancore began in 1879. In 1935, 59 percent of the people of southern Kerala were protected, and by the following year nearly everyone in that area was. Similar programs attacked cholera and malaria. The latter disease required cleaning up mosquito breeding areas, which is a more difficult task than vaccination. Kerala entirely eradicated smallpox by 1970, becoming India's first state to do so. Malaria has also been wiped out, and, in contrast to many parts of India, the area hasn't seen a recurrence of it.

Kerala has India's most extensive medical facilities as well. By investing relatively more of its state budget in medical facilities, in 1982 Kerala had nearly four times as many hospitals and nearly twice the number of hospital beds per 100,000 people as the Indian average. The doctor-to-patient ratio was 18 percent above average, and Kerala spent 35 percent more per capita on health care (*see the table on page 50*).

Medical services are available throughout Kerala, and rural hospital beds are much closer to patients than is the case in the rest of India. This helps explain why, since 1965, 80 percent of all patients have received their treatment at hospitals rather than at less well-equipped primary health centers. The second-best state, Tamil Nadu, has a 54 percent hospital treatment rate.

The state's provision of basic health care and its redistribution of wealth are the main explanations for a dramatic decline in birth rates. The 1986 rate of 22 per 1,000 women of childbearing age was about a third below India's average. The birth rate declined first in the districts of Travancore and Cochin, where public-health measures and access to health facilities developed earliest. K. Mahadevan and M. Sumangala found that in one Travancore suburb medically qualified personnel attended 72 percent of all births, compared with 8.5 percent in a village in Andhra Pradesh state.

The same study reported on routine practices at one

BASIC SERVICES (LATE 1970s)	RANK OF KERALA AMONG ALL INDIAN STATES	PERCENT OF VILLAGES WITH SERVICE IN KERALA	PERCENT OF VILLAGES WITH SERVICE IN INDIA
WITHIN 2 KILOMETERS			
All-weather roads	1	98	46
Bus stops	1	98	40
Post offices	1	100	53
Primary schools	1	100	90
Secondary schools	1	99	44
Fair-price (ration) shops	1	99	35
Health dispensaries	1	91	25
Health centers	1	47	12
WITHIN 5 KILOMETERS			
Higher education facilities	1	97	21
Hospitals	1	78	35
Fertilizer depots	1	93	44
Agricultural pump-repair shops	1	65	19
Veterinary dispensaries	1	82	45
Credit cooperative banks	1	96	61
Other banks	1	96	40
Seed stores	2	63	40
Storage and warehouses	4	34	21
Railway stations	8	23	18
IN THE VILLAGE			
Drinking water	5	96	93
Electricity	3	97	33



primary health center in Travancore, pointing up features that hundreds of millions of people in underdeveloped nations can only dream of. All the staff were regularly at work, doctors and nurses came mostly from the same caste and gender as patients, and the chief physician visited neighborhood sub-stations daily. The staff could refer serious cases to a fully equipped hospital nearby. The staff included even more women than the law required, boosting family-planning efforts.

A Literate People

Any development effort seeks to increase economic and social mobility, and education is one of the most powerful tools for prying loose rigid social structures. It provides training and skills, and it can elevate the self-esteem of the most oppressed so they can participate more fully in development. In Kerala, education reaches even the poorest people.

Kerala stands out for its remarkable achievements in raising literacy levels. It has been well ahead of the rest of India since at least the beginning of the twentieth century, and the state continues to expand educational opportunities at about the same rate as the nation. Kerala also stands far above the country as a whole in providing education across the barriers between genders, castes, and urban and rural areas.

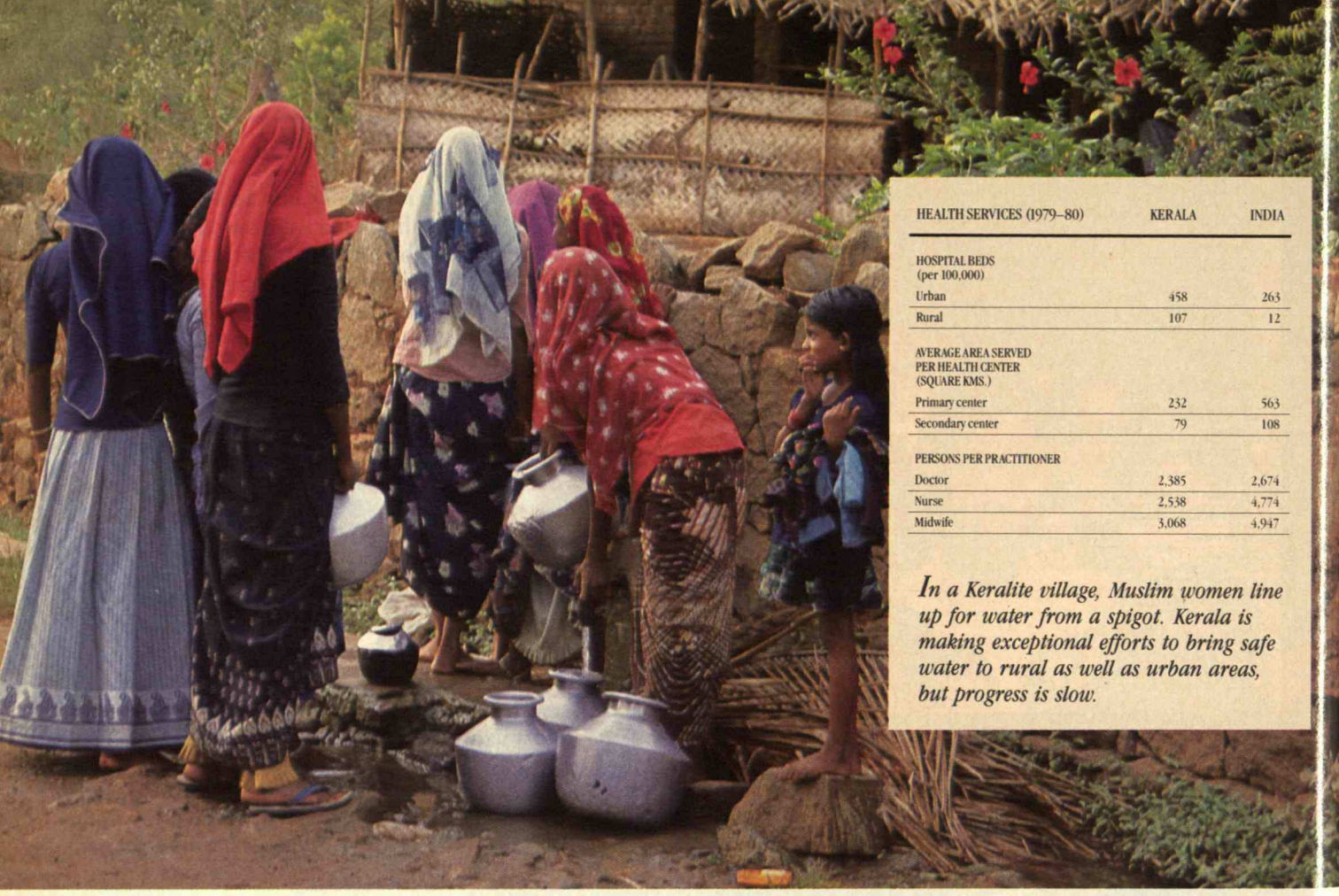
Kerala's early educational achievements came from a series of enlightened rulers, who saw such steps as a way to resist a large-scale Christian missionary assault. By the early twentieth century, however, the story became one of people struggling for knowledge, dignity, and better jobs, with caste improvement associations leading the way. A lower-middle-caste group, the Ezhavas, acted first, establishing the Ezhava Social Reform Movement in 1905. Caste-improvement leaders also began founding magazines, working with trade unions and other organizations of the poor, and promoting rationalism and scientific thinking as weapons for overthrowing the traditional Hindu caste system.

Literacy became a major tactic for awakening worker and low-caste consciousness. Reading and writing circles were set up in villages. Prominent authors wrote stories and poems with strong Marxist and labor themes, and workers published poetry and narratives in union-sponsored publications. Village libraries were established, and literacy became a demand of the growing radical movement. By the early 1980s, Kerala had 4,977 officially recognized village libraries, supported by community contributions and small state grants.

As a result, the literacy rate for low-caste people in Kerala is much greater than in the rest of India, and the education gap between higher and lower castes is the smallest. However, the continuing poverty of the former untouchables severely limits their ability to use Kerala's vastly expanded educational services. Most low-caste parents are still agricultural laborers, and they often must put their children to work in the fields during school hours to earn additional household income.

One solution to this problem is the lunch program, which helps keep low-caste children in school. Equally important is a large scholarship system. By 1988 over 587,000 low-caste and tribal students received scholarship aid—79 percent of all students in those categories. Another 65,000 got scholarships to higher level technical schools and colleges, and over 3,400 received dormitory accommodations and clothing allowances.

Two other striking features mark Keralite education. First, unlike other Indian states, Kerala has focused its expenditures on lower school levels, spreading basic literacy farther but leaving higher education less advanced. Second, non-government education has played a major role. In 1963, the Kerala Peoples' Science Move-



HEALTH SERVICES (1979–80)	KERALA	INDIA
HOSPITAL BEDS (per 100,000)		
Urban	458	263
Rural	107	12
AVERAGE AREA SERVED PER HEALTH CENTER (SQUARE KMS.)		
Primary center	232	563
Secondary center	79	108
PERSONS PER PRACTITIONER		
Doctor	2,385	2,674
Nurse	2,538	4,774
Midwife	3,068	4,947

In a Keralite village, Muslim women line up for water from a spigot. Kerala is making exceptional efforts to bring safe water to rural as well as urban areas, but progress is slow.

ment (KSSP) formed with the aim of "mobilization of the people through science." During the 1970s, the KSSP set up village study classes, medical camps, and literacy programs. Moreover, *jathas*—or parades—have taken puppet shows, guerrilla theater, and other informal modes of science education into neighborhoods and villages, telling people about environmental and other issues. In the 1980s, the KSSP has carried out mass education programs on AIDS and maternal health, and now publishes a widely read science magazine.

Kerala's citizens make great use of education. They boast the highest per capita newspaper consumption in India. There is also a substantial local magazine- and book-publishing industry. And the state exports educated employees to Bombay, Delhi, and the Middle East. Even Europe and the United States employ a significant number of Kerala nurses.

Many low-caste people who have gained literacy have become government employees, as well as officers in farmworkers' and other unions. The cabinet elected in 1957 included four former untouchables, as did a progressive coalition a decade later. In 1971 a former untouchable became a district collector, one of the highest appointive administrative offices. Caste and tribe representation in higher government jobs reached 10.4 percent in 1988, essentially in proportion to their share of the population.

Unemployment: Kerala's Most Visible Failure

In contrast to these impressive gains, Kerala's economy suffers from serious unemployment. Between 1972 and 1973, the rate was 25 percent; the official India figure was 8 percent (probably an underestimate). Unemployment in Tamil Nadu, with the second-highest rate, was 12 percent. The figures for Kerala and India were little different 15 years later.

Is Kerala's unemployment a consequence of reform? In other words, has a welfare mentality developed, in which people feel no need to work? That might be the case if the unemployment were recent, but Kerala's problem seems to go back at least to the beginning of this century.

Another sign that a welfare mentality might have developed would be a rapidly declining work-participation rate—the percent of the total population who are in the labor force. But since 1961 that rate has dropped more slowly than it has for India as a whole, so Kerala appears to have improved its relative position. In part, the figures reflect the tremendous emigration of Kerala workers. By 1987 over 682,000 people had gone outside the state looking for work, indicating that Keralites seek employment whenever possible, even at the cost of leaving their homes.

Although some analysts claim that high wages are the main cause of Kerala's unemployment, there is no

conclusive evidence of this. Some private entrepreneurs have moved cashew-processing factories across the state border into neighboring states, for example, in search of cheaper labor. But most of Kerala's unemployment significantly predates the union-won wage increases of recent years and thus appears attributable to longer-term factors in the state's economic history.

Clearly, though, Kerala's advances soften the consequences of underemployment. First, higher wages cushion workers for the periods when they are unemployed. Second, various welfare programs compensate for some lost wages—including unemployment insurance, agricultural laborers' pensions, and a 35-rupee annual subsidy per year per child to many former untouchables. Third, rural workers obtain some food security from the house-compound plots they won in the land reform.

However, such mechanisms can never fully offset unemployment. Lack of work means lack of economic opportunity as well as lagging productivity. It signals wasted human resources and is the greatest challenge Kerala planners and politicians face. The Left Democratic Front government elected in 1987 has proposed programs to stimulate local investment in small-scale, rural industry, but it is too soon to tell whether such programs can effectively raise employment levels.

Lessons From Kerala

The Kerala model cannot be copied wholesale, but it provides a standard for evaluating and improving the development efforts of other societies. In this spirit, we offer a few tentative lessons from the Kerala experience.

■ Radical reforms deliver effective benefits to the poor even when per capita income remains low. The benefits of Kerala's reforms are unmatched in other Indian states or most Third World nations. Moreover, the achievements are mutually reinforcing. Land reform, for example, removed the threat of eviction, enabling tenants to participate in politics more.

■ Public food distribution is highly effective in very poor agrarian economies. Kerala's school and nursery feeding programs, and especially its thorough rationshop system, ensure a minimum food package to nearly everyone. Low prices help people remain free of the private moneylenders that are a source of exploitation in much of the Third World.

■ Devoting resources to public health and health care can lower infant mortality and birth rates and raise life expectancy, even when incomes are low and stagnant. Kerala proves that these services need not wait for growth even in the poorest regions.

■ Widespread literacy and education can help break down traditional social barriers and create a more just social order. Although many Third World nations recognize the need for education, they devote far too little to either basic literacy or rural programs.

■ Land reform can reduce economic and social inequality and put important productive resources into the hands of the poor. To the extent that wealth and income are derived from land, only breaking the hold of the landed elite can liberate the poorest small farmers.

■ Progressives—including communists—can play a major and positive development role. Kerala's two communist parties are independent of any other country. They have a reputation, even among opponents, for being relatively honest and free of corruption. When their candidates win elections, they do not institute undemocratic practices such as censoring the media or repressing opponents. Kerala suggests that the West and development agencies rethink their automatic hostility to communists.

■ Redistribution doesn't necessarily create employment or raise the average income. Kerala's reforms have not raised agricultural production or alleviated unemployment—both chronic problems in many Third World economies. The expansion of public service also comes at a price. While redistribution may shift assets of the rich to the poor, everyone does pay for some of Kerala's policies. The per capita tax revenue in 1975 was 11 percent of average income, while most Indian states taxed at rates between 6 percent and 10 percent.

■ Still, radical reform can shield the poor from recessions. In the Third World, the effects of the capitalist economic roller coaster have been intense. Many countries have suffered zero or negative economic growth in the 1980s. A 1988 UNICEF study estimates that the 1980s recession caused 60,000 child deaths in Brazil.

Certainly recessions hurt Kerala, but land redistribution, food rationing, pensions, and the like insulate the poorest from the business cycle. While many Third World governments are cutting education and medical services to pay their debts to banks in rich nations, the left coalition government elected in Kerala in 1987 has expanded access to school lunches and pensions. The government also increased per capita education expenditures 16 percent in 1987 and 5 percent in 1988; it raised health expenditures 20 percent in 1987 and 10 percent in 1988.

Announcing his agency's 1989 report, UNICEF director James Grant noted, "In the '60s and '70s, tremendous emphasis was put on how you get better GNP growth rates. But GNP growth rates can hide mass maldistribution of income. . . . In the '90s, the target ought to be meeting more tangible human targets: assuring safe water, assuring access to health services, assuring basic education."

Kerala offers lessons in how to hit those targets. ■


Patent

By Brian Kahin

The Software Patent Crisis

An explosion of patents on software processes may radically change the programming industry—and our concept of human expression in the computer age.

Last August, Refac International, Ltd., sued six major spreadsheet publishers, including Lotus, Microsoft, and Ashton-Tate, claiming they had infringed on U.S. Patent No. 4,398,249. The patent deals with a technique called "natural order recalc," a common feature of spreadsheet programs that allows a change in one calculation to reverberate throughout a document. Refac itself does not have a spreadsheet program and is not even in the software industry. Its business is acquiring, licensing, and litigating patents.

Within the last few years, software developers have been surprised to learn that hundreds, even thousands, of patents have been awarded for programming processes ranging from sequences of machine instructions to features of the user interface. Many of the patents cover processes that seem conventional or obvious, and developers now fear that any of the thousands of individual processes in their programs may be subject to patent-infringement claims.

The Refac suit demonstrates the vulnerability of the industry to such claims. Patent no. 4,398,249 was applied for in 1970, granted in 1983, and only recently acquired by Refac. In the meantime, soft-

ILLUSTRATIONS: KEVIN HAWKES

ware developers have been busily creating spreadsheets and other new products unmindful of patents. The industry accepted copyright and trade secret as adequate protection for its products, and most programmers assumed that patents were not generally available for software.

Never before has an industry in which copyright was widely established suddenly been subjected to patenting. As it is, only a few companies that create microcomputer software have the resources to try to defend against patent infringement claims. Most small firms will be forced to pay license fees rather than contest the claims, even though many software patents may not stand up in court.

In the long run, the costs of doing business in a patent environment will radically restructure the industry. Many small companies will fold under the costs of licensing, avoiding patent infringement, and pursuing patents defensively. The individual software entrepreneur and inventor may all but disappear. There will be fewer publishers and fewer products, and the price of software will rise to reflect the costs.

Especially disturbing is that the broad claims of many recent software patents appear to establish monopolies on the automation of such common functions as generating footnotes and comparing documents. Some claims even cover processes for presenting and communicating information, raising troubling questions about the effect of patents on the future of computer-mediated expression.



Patent vs. Copyright

Software patents, like all patents, give an inventor the right to exclude all others from making, selling, or using an invention for 17 years. In return, the patentee discloses his or her "best method" of implementing the invention, thereby relinquishing trade secrets that might otherwise be enforced forever (like the formula for Coca-Cola).

To obtain a patent, an applicant must convince Patent Office examiners that the invention would not be obvious to a "person of ordinary skill in the art" who is familiar with all the "prior art," which includes previous patents and publications. In contrast, copyright inheres in books, poems, music, and other works of authorship, including computer programs, from the moment they are created. Registering one's work with the Copyright Office is a simple, inexpensive procedure that has important benefits (it is a precondition for filing suit, for example), but the copyright itself is automatic when the work is fixed on paper or on disk.

Copyright and patent protect different things. Copyright protects expression but not underlying ideas. Patents protect useful processes, machines, and compositions of matter. Traditionally "processes" have included methods of physically transforming materials but not business methods or mental steps. Thus, computer programs fall somewhere between the traditional territories of copyright and patent.

From the 1960s to the early 1980s, the Patent Office and the courts grappled with the question of whether algorithms—the elemental processes on which computer programs are built—are patentable as either processes or machines. Early on, the Patent Office

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granted some patents for processes built into computer hardware that today would be contained in software, but it was reluctant to grant patents for programs per se. As the 1966 Report of the President's Commission on the Patent System pointed out, the Patent Office had no system for classifying programs. The report also noted that even if this were remedied, the volume of programs being created was so enormous that reliable searches of "prior art" would not be feasible or economical.

A modern software package may contain thousands of patentable processes that developers now could be forced to excise or design around.

However, the Court of Claims and Patent Appeals (CCPA) maintained that computer programs were patentable and overturned numerous Patent Office decisions denying patentability. The Supreme Court vindicated the Patent Office in two decisions, Gottschalk v. Benson (1972) and Parker v. Flook (1978), holding that mathematical algorithms were not patentable subject matter. Still, the CCPA continued to uphold patentability in other cases. Finally, in Diamond v. Diehr (1981), a sharply divided Supreme Court upheld the patentability of a process for curing rubber that included a computer program. The majority concluded that programs that did not preempt all uses of a computer algorithm could be patented—at least when used in a traditional process for physically transforming materials.

That case has been the Supreme Court's last word on the subject. But despite the narrowness of the ruling, the Patent Office underwent a radical change of heart. Until very recently, there were no reported appeals of adverse Patent Office decisions, leading observers to conclude that the office was eventually granting almost all applications for software patents. Although articles began appearing in legal periodicals a few years ago noting that patents were being routinely granted for many software processes, not until 1988 did the industry realize that the rules were changing, or had already changed, in the middle of the game. By the spring of 1989, the patents that entered the pipeline after Diamond v. Diehr were starting to flow out in significant numbers—by one count, nearly 200 in the first four months of that year.

Processing Problems

Unfortunately, the Patent Office classification system remains unchanged, and the volume of software being created has grown exponentially. This makes searching for prior art—processes already in public use—time-consuming and expensive.

The search is extraordinarily difficult because the field's printed literature is thin and unorganized. Software documents its own design, in contrast to physical processes, which require written documentation. Also, software is usually distributed without source code under licenses that forbid reverse engineering. This may amount to suppressing or concealing the invention and therefore prevent the program from qualifying as prior art. The search for prior art may require securing oral testimony from people who developed software at universities many years ago, an expensive proposition.

Many programmers suspect that patent examiners lack knowledge of the field, especially since the Patent Office does not accept computer science as a qualifying degree for patent practice (it accepts degrees in electrical engineering). Moreover, attracting and holding individuals with expertise in a field like software, where industry demand is high, is not easy for a government agency. Less qualified examiners create problems because they naturally have a lower standard in determining the hypothetical "person having ordinary skill in the art," and are thus more apt to grant patents for obvious processes. Since the examination process is conducted ex parte (as a private matter between the Patent Office and the applicant), less qualified personnel are also more likely to be influenced by sophisticated patent attorneys and the apparent expertise of the applicant.

The quality of software patents being awarded has aroused concern even among patent lawyers and other advocates of the new regime. But it will be left to firms being sued for infringement to prove that a process should not have been patented because it was obvious in view of the prior art. Meanwhile, software patents stand as intimidating weapons for those who hold them.

Restructuring the Industry

Perhaps because of some of these problems, applications for software patents take an average of 32 months to be approved and published. That's significantly

longer than the overall average of 20 months, and a very long time given the short product cycles of the software business.

Unlike copyright, independent creation is irrelevant to patent infringement. Every developer is charged with knowledge of all patents. Even if someone is not aware of a patent, he or she can still infringe against it. Furthermore, patent applications and the examination process are confidential, so there are ordinarily several years of patents in the pipeline that no search will reveal. Although no infringement occurs until the patent issues, an inventor may find that a newly awarded patent covers a feature he or she has already incorporated and marketed in a finished product. While this is a problem for the patent system as a whole, it is intolerable for software developers because of the industry's rapid pace of innovation and long patent-processing period.

The problem is compounded by the fact that a modern software package may contain thousands of separately patentable processes, each of which adds to the risk of infringing patents that are already in the pipeline. Since software functions are interdependent and must be carefully integrated, developers can find it difficult to excise a process built into the original program.

The patent system exacts a high penalty in an industry as decentralized as software. Programming requires no special materials, facilities, or tools: to design software is to build it. Because barriers to entry are low, the industry attracts many small players, including hundreds of thousands of individuals who work as consultants or short-term employees. Rather than a handful of competitors working on the same problem, there are likely to be dozens, hundreds, even thousands. Since under the patent system one winner takes all, many others—including developers without lawyers—are deprived of the fruits of their independent labor and investments.

Patent proponents argue that this uninhibited duplication of effort wastes resources. But the "waste" could be cut only by reducing the number of players and slowing the pace of development to fit the cycles of the patent system. The result would be a handful of giants competing on a global scale, bidding for the ideas and loyalty of inventive individuals.

However, many programmers believe that there are diseconomies of scale in software development—that the best programs are authored rather than assembled. The success of Visicalc, Lotus 1-2-3, WordPerfect, and other classic programs testifies to the genius of individuals and small teams. Certainly there has been no evidence that they need more incentives. Quite the contrary, the freewheeling U.S. software industry has been a model of creative enterprise.

A Costly System

Even software developers and publishers who do not wish to patent their products must bear the costs of operating under a patent system. While these costs may initially come out of the software industry's operating margins, in the long run, they will be borne by users.

Since one winner takes all under the patent system, thousands of small players in the software industry may be denied the fruits of their labor.

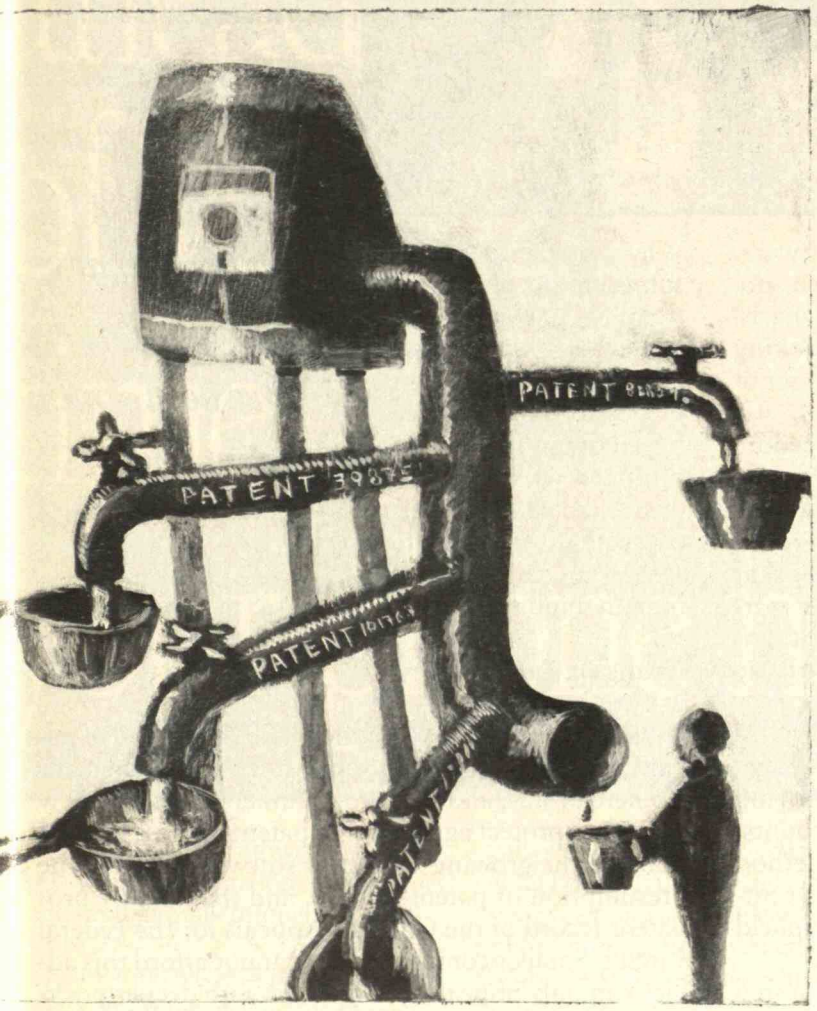
At the first level is the expense of analyzing prior art to avoid patent infringement. A precautionary search and report by outside patent counsel can run about $2,000—that's per process, not per program.

Next are the direct costs of the patent monopoly—the license fees that must be paid to patent holders. If the patent holder refuses to license at a reasonable fee, developers must design around the patent, if that is possible. Otherwise, they must reconceive or even abandon the product.

The third set of costs are those incurred in filing for patents. Searching for prior art, plus preparing, filing, negotiating, and maintaining a patent, can total $10,000 to $25,000, not including internal staff time. Seeking foreign patents can make the bill substantially higher.

The notoriously high costs of patent litigation must be borne by both sides. Just the discovery phase of a lawsuit is likely to cost each side a minimum of $150,000, and a full trial can cost each from $250,000 to millions. Again, these figures do not include internal staff time, which could easily double the real cost. While a small patent holder may be able to secure a law firm on a contingency basis or sell an interest in the patent to speculators, the defendant has no such options.

Litigation also involves the possibility and further expense of an appeal. All appealed patent cases now go directly to the Court of Appeals for the Federal Circuit (CAFC, successor to the CCPA), where panels in patent cases are usually led by patent lawyers turned judges. Whereas patents once fared poorly on appeal, the CAFC has found patents to be both valid and infringed in over 60 percent of the cases that have come before it. The CAFC has greatly strengthened the presumption of patent validity and upheld royalties ranging from 5 to 33 percent.



While a large software company may be able to absorb these costs, they will disproportionately burden smaller companies. The first to suffer will be independent developers who cannot afford to market their own products. These developers typically receive royalties of 10 to 15 percent from publishers who serve as their distributors. Such modest margins, out of which developers must recoup their own costs, would be wiped out by the need to pay royalties to a few patent holders.

The high costs of a patent environment give patentees considerable leverage over small firms who will, as a practical necessity, pay a license fee rather than contest a dubious claim. To establish credibility, the patentee will settle for small fees from the initial licensees. The patent holder can then move on to confront other small firms, pointing to such licensings as acknowledgments of the patent's validity and power. This tactic has a snowballing effect that can give the patent holder the momentum and resources to take on larger companies.

Cross-licensing—where firms secure patents to trade for the right to other patents—seems to work reasonably well in many industries and has been touted as the answer to these problems. However, cross-licensing is of little value to smaller companies, which have little to bring to the table. And cross-licensing may prove of limited value even to large companies, since it does not protect against companies like Refac that have no interest in producing software and therefore no need to cross-license.

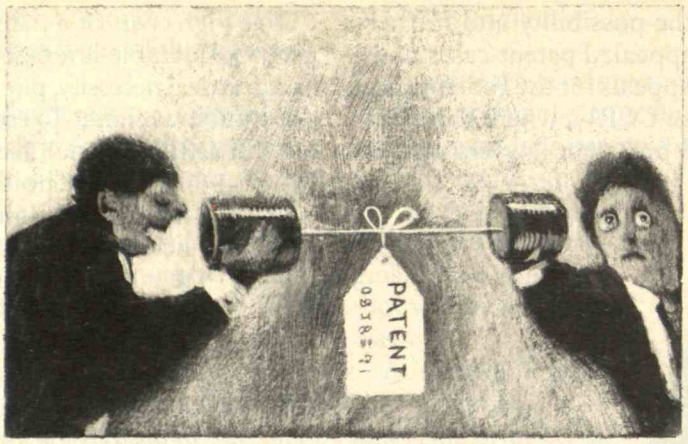
Of course, the power that software patents afford may induce some venture capitalists to invest in them. But investing in software patents is one thing; investing in robust, complex products for a mass market is another.

In fact, software publishers hold very few patents. The vast majority are held by large hardware companies, computer manufacturers that have in-house patent counsel and considerable experience in patenting and cross-licensing. Nearly 40 percent of the software patents that the U.S. Patent and Trademark Office now issues go to Japanese hardware companies. It is quite possible that the separate software publishing industry may cease to exist as companies find that they need the patent portfolios and legal resources that the hardware giants can provide. The result will be a loss of diversity in software products, reduced competition, and, many believe, a less productive software industry.

Protecting Ideas and Information

A deeper, more disturbing problem in patenting programs was barely evident before computers became ubiquitous personal tools and software became infinitely versatile. More than a "universal machine," the computer has developed into a medium for human expression and a mediator of human experience. Soft-

ware is designed to satisfy specific needs for shaping and delivering information. Thus, what is increasingly at stake in software patents is the generation and flow of information. This becomes more threatening when the claims in a patent extend far beyond the disclosed means of implementation to cover general ideas.



Broad patent claims covering abstract processes are not limited to software, or even to computer hardware. Consider patent no. 4,170,832, granted in 1979 for an "interactive teaching machine." The patent discloses a clumsy-looking combined videotape deck and television with a set of push buttons.

The patent includes a process claim for a procedure commonly used in interactive video: showing an introductory video segment, presenting the viewer with a limited number of choices, registering the viewer's decision, and then revealing the likely outcome of that decision. The disclosed machine, which was never marketed, contributes nothing to the public domain: it simply reveals one person's way of implementing a basic instructional technique.

In a notorious 1983 case, a federal district court upheld the patentability of Merrill Lynch's Cash Management Account system, a procedure for moving investment funds among different types of accounts. Acknowledging that the system—essentially a method of doing business—would not be patentable if executed with pencil and paper, the court nevertheless upheld the patent because it made use of a computer.

The Patent Office has taken this principle one step further. Besides granting monopolies on new procedures such as the Cash Management Account system, the office is also awarding patents merely for automating familiar processes such as generating footnotes (patent no. 4,648,067) and comparing documents (patent no. 4,807,182). But software developers have been routinely automating such common office functions, bookkeeping procedures, learning strategies, and modes of human interaction for years. The principle that patents are granted to induce inventors to disclose trade secrets has no relevance here. These processes are part of everyday life, and can and should be computerized in a number of ways.

What's more, information per se is traditionally the substance and territory of copyright. The intelligent ordering of information is the very heart of grammar, rhetoric, and graphic design.

The Patent Office has begun granting monopolies on computerized office procedures and learning strategies that programmers have been routinely automating for years.

Why should information be subject to the pervasive restraints of patent simply because it is interactive rather than linear? Should human expression that is assembled, communicated, or assimilated with the aid of a computer be restrained by patents? If the computer is seen as an extension of the human mind rather than vice versa, the answer is no.

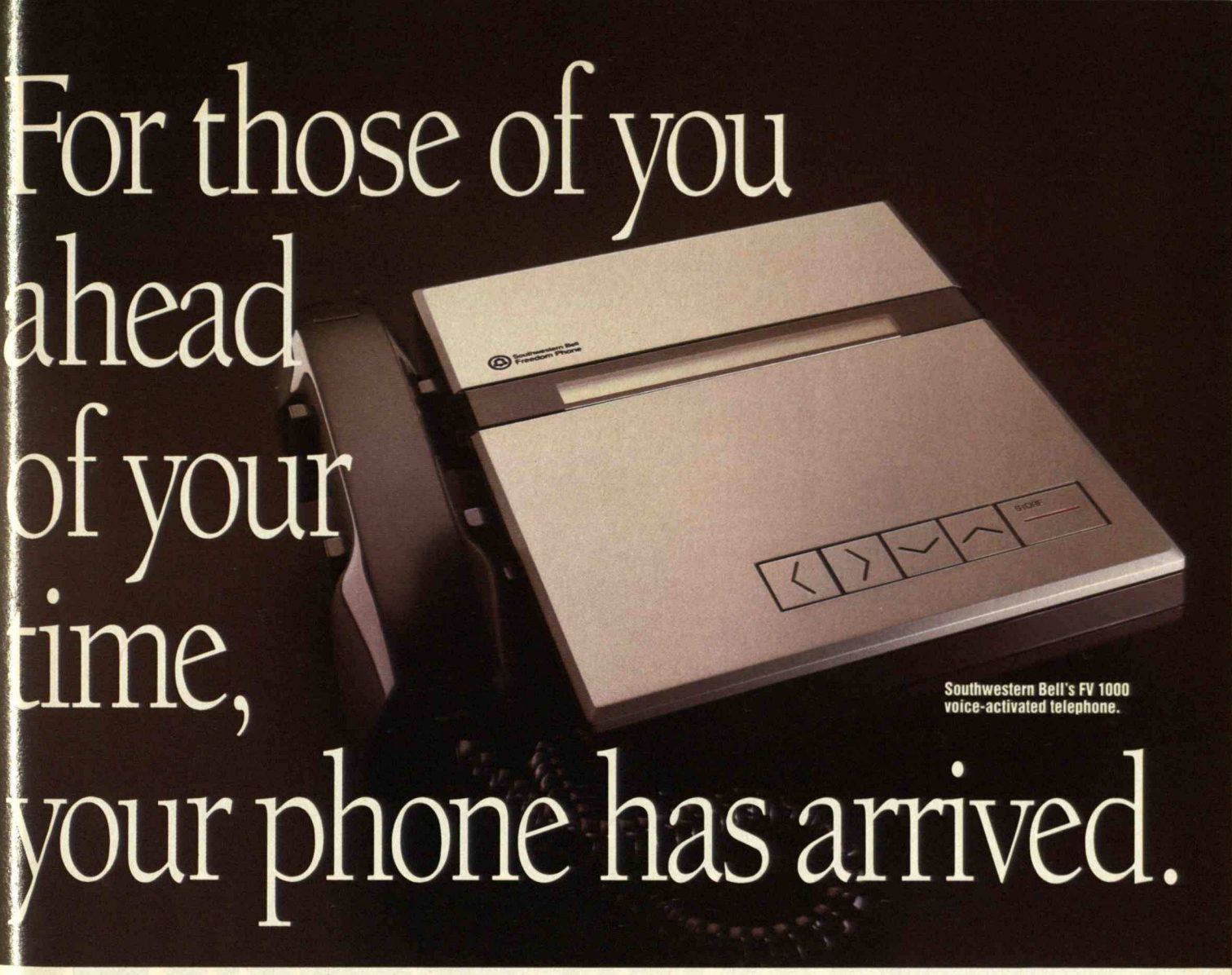
Changing Patent Policy

Software developers who understand the impact of patents are demoralized. Lawyers assure them that patents are here to stay, and that programmers must seek new patents to protect against other patents. These lawyers point to the growing torrent of software patents, the presumption of patent validity, and the fervidly propatent record of the Court of Appeals for the Federal Circuit. Smaller companies that cannot afford this advice can only hope that companies with deeper pockets will afford more visible and attractive targets for patent holders bringing suit.

But the narrowness of the Supreme Court decision in Diamond v. Diehr remains. The Court never explicitly rejected the traditional doctrines against the patentability of mental steps and business methods, doctrines that may yet defeat many of the patents that have issued. If the hue and cry grows, Congress could amend the Patent Act to make it clear that the scope of patenting is still limited to physical processes.

The software industry was not broke, but it is in the process of being "fixed." The question is whether the fixing will be done by the gush of awards from private proceedings in the Patent Office—or by a public decision about whether software patents serve "to promote the Progress of Science and useful Arts," as the Constitution requires. ■

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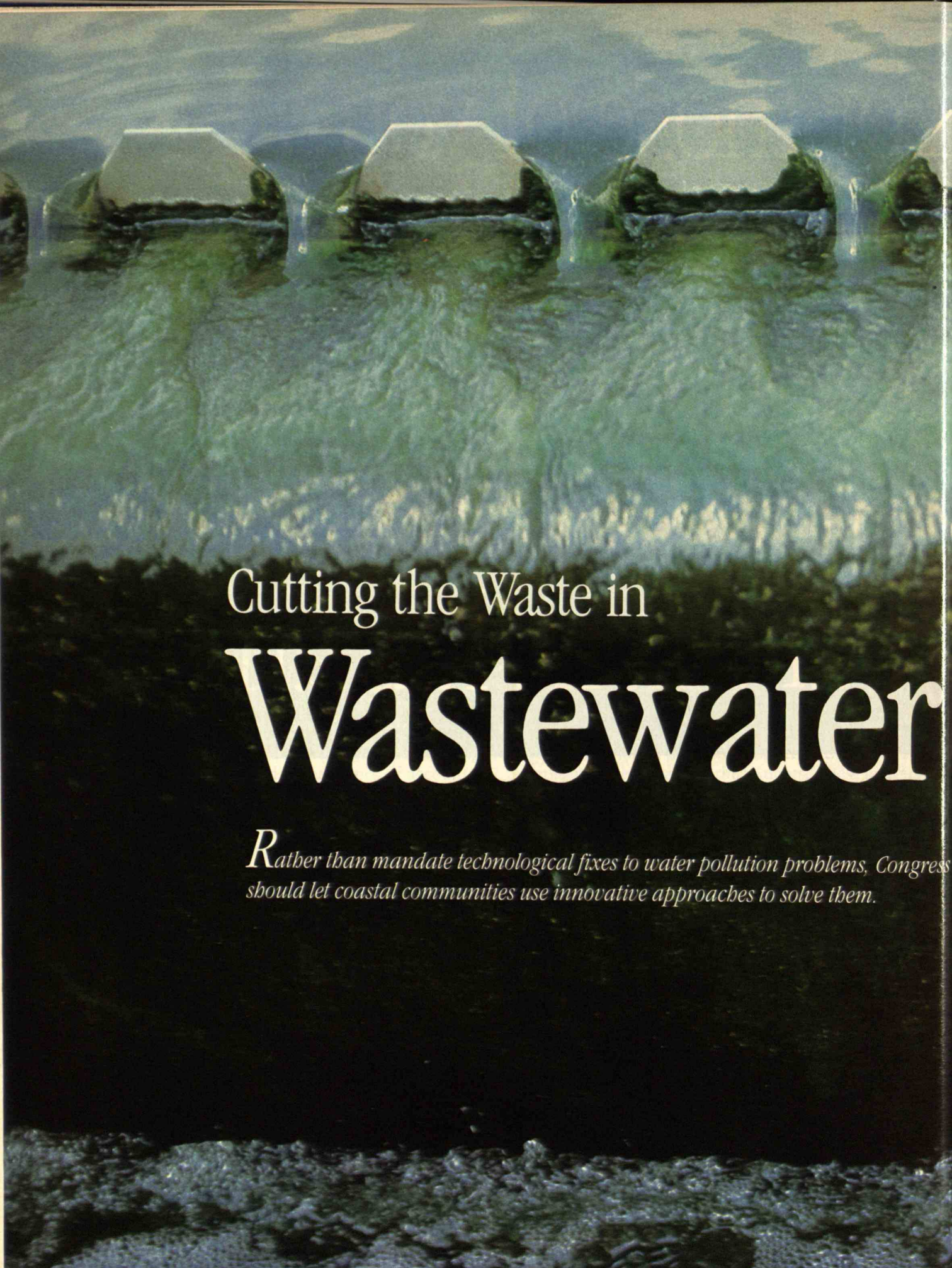
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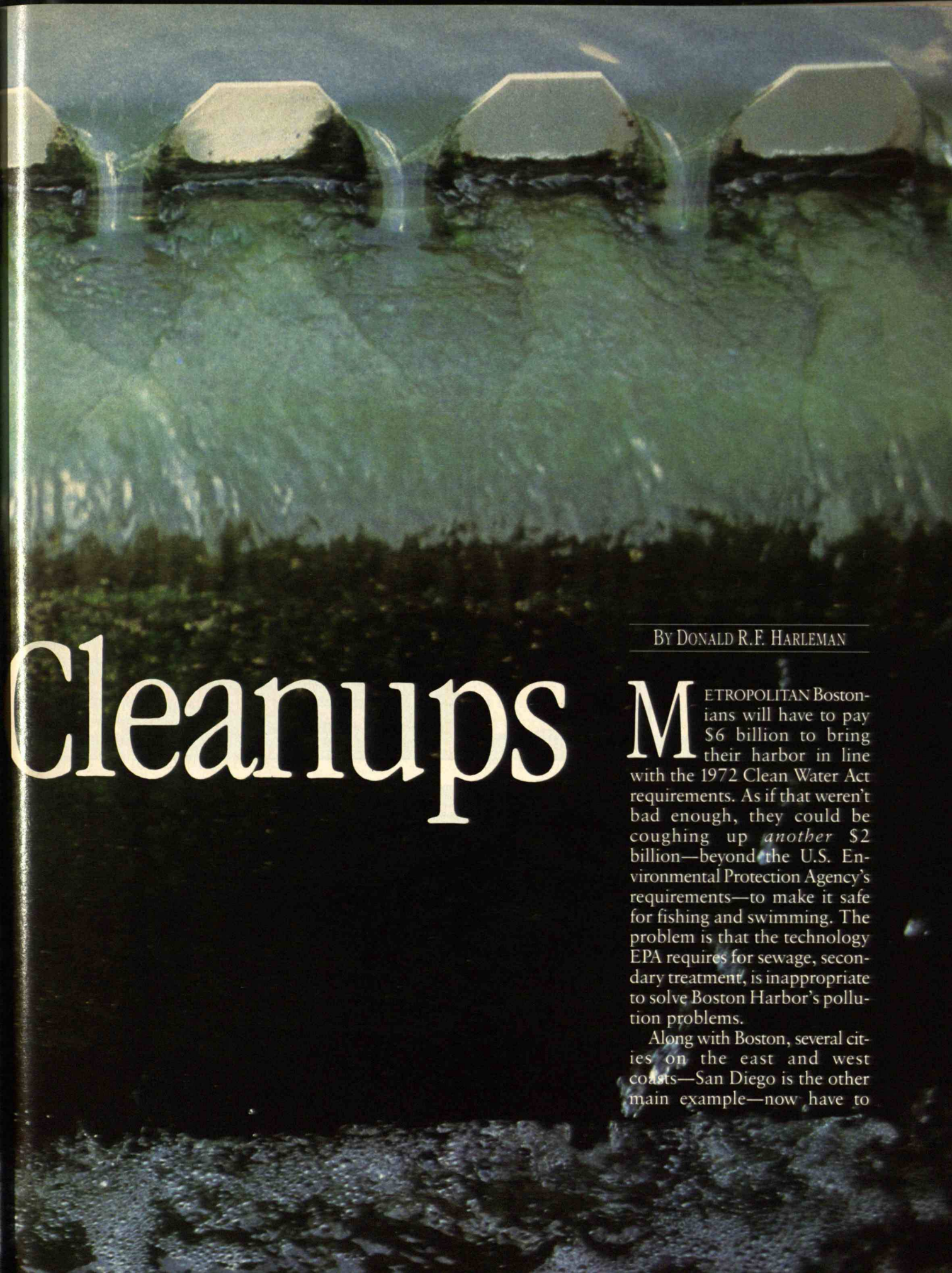
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Cutting the Waste in Wastewater

Rather than mandate technological fixes to water pollution problems, Congress should let coastal communities use innovative approaches to solve them.

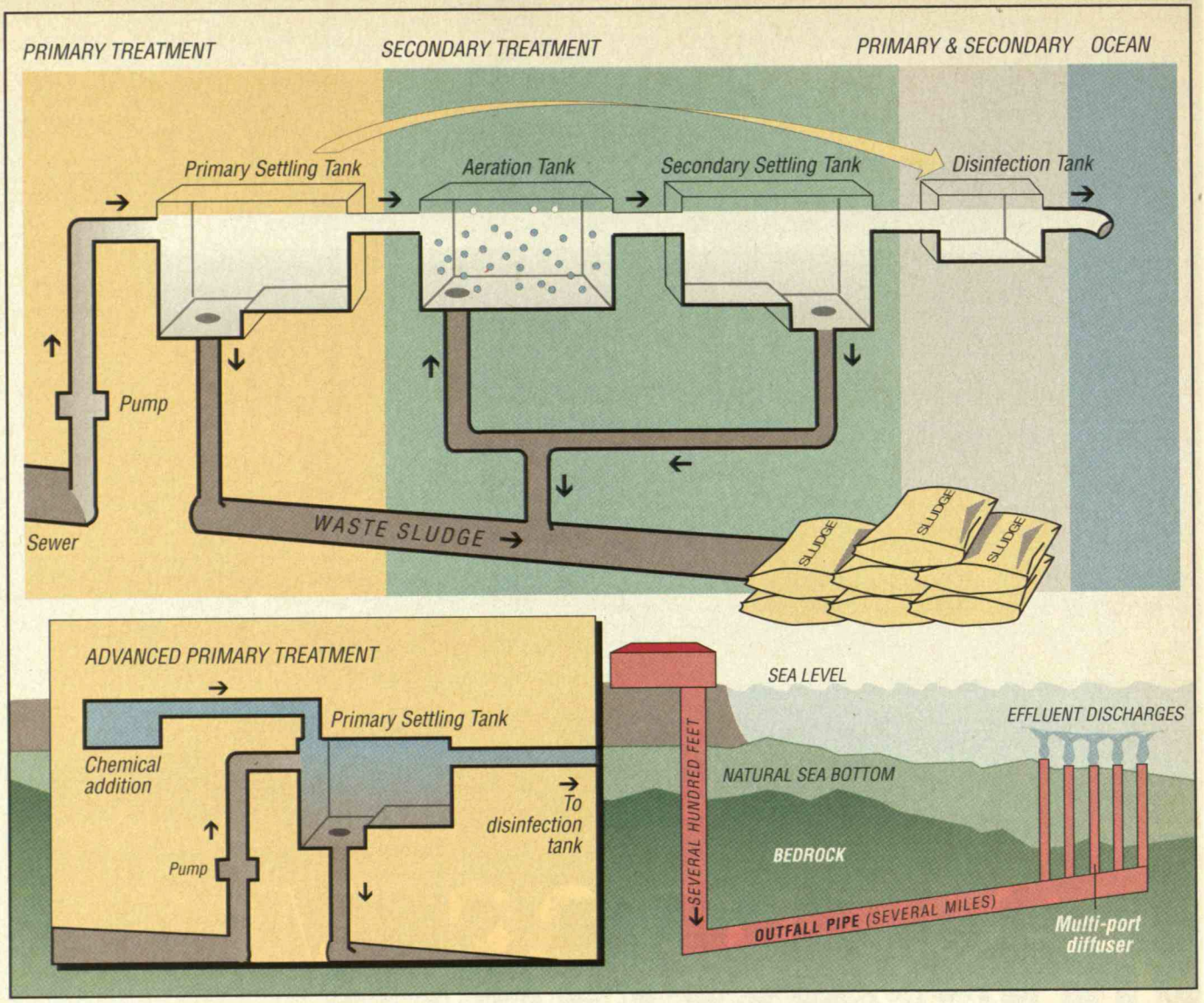


Cleanups

By Donald R.F. Harleman

METROPOLITAN Bostonians will have to pay $6 billion to bring their harbor in line with the 1972 Clean Water Act requirements. As if that weren't bad enough, they could be coughing up *another* $2 billion—beyond the U.S. Environmental Protection Agency's requirements—to make it safe for fishing and swimming. The problem is that the technology EPA requires for sewage, secondary treatment, is inappropriate to solve Boston Harbor's pollution problems.

Along with Boston, several cities on the east and west coasts—San Diego is the other main example—now have to



Above, top: The conventional methods of processing wastewater consist of either primary treatment or both primary and secondary treatment. In primary treatment, the water proceeds from one tank, where suspended solids settle and are siphoned off as sludge, to another tank, which is for disinfection. During secondary treatment, the water is mixed with oxygen and sent for a second round of settling. Much of the resulting sludge is recycled through the aeration tank, where the amount of polluting organic material known as BOD is reduced. The excess sludge is drained off. In coastal cities the cleaned water is finally sent to the ocean.



Above, bottom left: In advanced primary treatment, a new technology that produces less sludge than secondary treatment, chemicals are added to enhance the settling process before the water is disinfected. Above, bottom right: Secondary treatment is not always necessary to protect the marine environment. Wastewater from a treatment plant can be sent through an outfall pipe, sunk hundreds of feet into bedrock, that ends in a "multi-port diffuser" several miles out. Seawater dilutes the effluent that comes from the diffuser. Photo: Sludge is dried before disposal in landfills or use in agriculture.

PHOTOS: SAN DIEGO CLEAN WATER PROGRAM (PREVIOUS PAGE); ARONSON PHOTO, STOCK BOSTON (THIS PAGE). DIAGRAM: DEBORAH PERUGI DESIGN

SECONDARY TREATMENT PRODUCES ALMOST TWICE AS MUCH SLUDGE AS PRIMARY TREATMENT DOES. EPA IS CONCERNED ABOUT WHAT TO DO WITH THIS CONTAMINATING MATERIAL.

drum up most of the billions of dollars they need to build facilities for secondary treatment. The federal government has phased out most support it previously offered for this work. Such cities are essentially being told to ignore or delay cleanup actions that would be more environmentally beneficial and less costly. These include using a new technology known as advanced primary treatment, which results in much less sludge than secondary treatment; reclaiming water for reuse; and eliminating raw sewage flows into harbors during storms.

Why does EPA insist that most coastal communities use secondary treatment rather than sound alternatives? The answer is that the 1972 Clean Water Act mandates it. Requiring a uniform treatment technology has been simple to administer but has unfortunately frozen waste treatment at the 1972 level.

The issue is larger than what coastal communities should do about their sewage. Instead of trying to reach anti-pollution goals entirely through certain cleanup technologies, Congress needs to set environmental quality standards and ensure that communities adhere to them by the means they choose.

How Wastewater Is Cleaned

EPA defines wastewater treatment by how much it reduces two quantities—biochemical oxygen demand (BOD) and suspended solids—in effluent. BOD, a measure of organic matter, decreases the levels of dissolved oxygen in water. The extent of oxygen depletion depends on the amount of BOD in the effluent, and on the effectiveness of the process by which oxygen is transferred from air to water. If untreated or minimally treated wastes are discharged to a freshwater stream, dissolved oxygen may drop to a level harmful to aquatic life. The removal of suspended solids is important because they decrease water clarity, form bottom deposits, and tend to absorb toxic substances.

Primary treatment removes about 35 percent of the incoming BOD and 60 percent of the suspended solids in a series of sedimentation tanks. After secondary treatment, a biological process, about 85 percent of both BOD and suspended solids have been removed. Engineers add oxygen to the secondary treatment tanks to reduce BOD. This increases the population of bacteria that feed on the wastewater's organic material. After the bacteria die, they settle with the other suspended solids as a residue. The total amount of residue produced by combined primary-secondary treatment is about twice that produced by the primary stage alone.

The disposal of the residue, sludge, is an important technology-policy conflict. Various branches within EPA have charges to protect the water, atmosphere, and land. Each branch is concerned about sludge. Ocean disposal will be banned in 1992, air-quality standards effectively prohibit incinerating sludge that contains toxic waste, and EPA has proposed strict regulations on using the material for agriculture and land filling if it contains toxics. No federal environmental policy governing the water-air-land tradeoffs for sludge disposal has emerged. Also, procedures to remove toxics during wastewater treatment cannot substitute for a strong program to control them at their sources.

The Coastal Cities' Argument

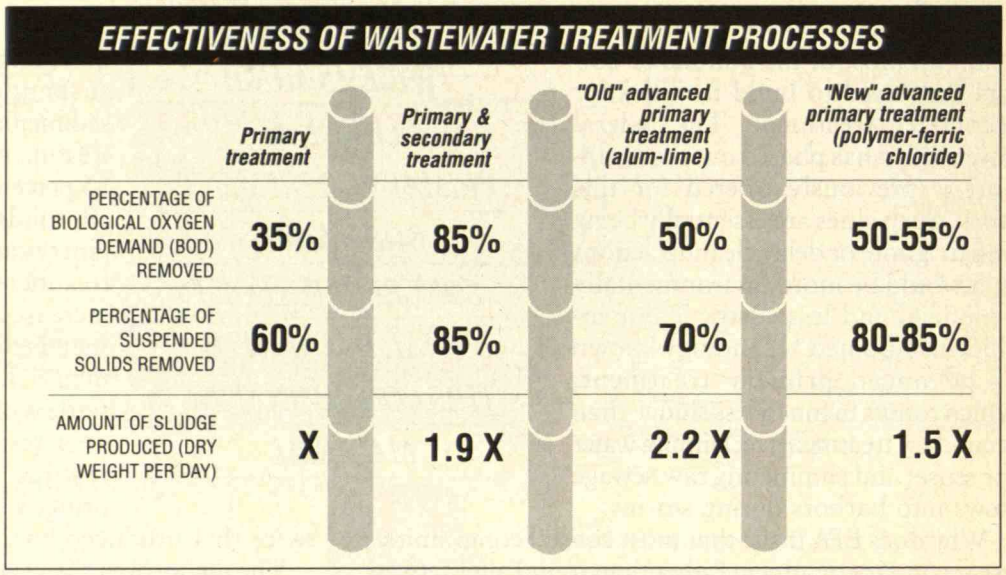
Secondary treatment is not always necessary to protect the marine environment. That's because wind and tides can mix and disperse water that has undergone primary treatment. In contrast to freshwater streams, where high BOD levels can kill aquatic life, ocean water has extensive surface area, which can reaerate incoming effluent. Therefore large BOD reductions are less important in coastal waters.

A relatively simple technology can greatly assist the mixing process. "Outfall" pipes carrying treated water extend to deep sections of ocean that are vigorously flushed by tides. These pipes terminate in "multi-port diffusers" thousands of yards long. The diffusers mix effluents by means of jet streams and lower the concentration of BOD and suspended solids more than 100-fold.

Soon after Congress passed the Clean Water Act, coastal municipalities pointed out these facts to feder-

DONALD R.F. HARLEMAN, Ford Professor of Civil Engineering at MIT, chairs an EPA-Army Corps of Engineers group that is evaluating models of pollution control for Chesapeake Bay. He also served as a consultant to the Metropolitan District Commission of Massachusetts when it applied for a secondary treatment waiver, and has headed MIT's Water Resources and Environmental Engineering Division.

Communities that send treated wastewater to the ocean must remove suspended solids beforehand. Although a combination of primary and secondary treatment eliminates more suspended solids than primary treatment alone does, it also produces almost twice as much sludge. However, a new form of advanced primary treatment can remove as high a percentage of suspended solids as secondary treatment while producing less sludge.



al legislators. Communities in the Los Angeles area that had been discharging primary effluent through outfall pipes amassed evidence showing why they should be exempt from secondary treatment. Congress was persuaded, and in the Clean Water Act's 1977 revisions it allowed municipalities discharging wastewater into the ocean to argue their cases before EPA administrators.

In 1979 EPA set up guidelines for communities to apply for a waiver of the secondary treatment requirement. Going against a fundamental principle of environmental-impact analysis, the agency did not let applicants evaluate incremental benefits by comparing the quality of their primary treatment wastewater with that undergoing secondary treatment. Instead, they had to prove that "less-than-secondary" treatment was "sufficient to protect marine water." Also, communities could only show whether their effluent discharges met state standards—which still might not lead to EPA's waiving the secondary treatment requirement.

Despite the prejudicial language of the regulation, more than 200 treatment districts applied for waivers. In the years that followed, EPA denied most applications, especially those of large communities. But the districts whose applications were turned down in the early and middle 1980s had little incentive to argue. At the time, EPA was funding 75 percent of the cost of mandated secondary treatment plants.

Federal construction grants started to be phased out in 1987, however, and all such money is now gone. The change has hurt communities for which EPA's review process has dragged on for a long time. In some, the construction of new treatment plants did not begin until the late 1980s, and in others it is still pending.

A New Way to Clean Water

Since the mid-1980s, Los Angeles, San Diego, and the adjoining counties of Los Angeles and Orange have started using a reasonable alternative to secondary treatment: advanced primary treatment. This innovative process should render moot the old waiver issue of conventional primary versus secondary treatment.

Advanced primary treatment uses polymers—long chains of organic molecules—and ferric chloride. These additives cause suspended solids to coagulate, which means that they settle more and are easier to remove. Engineers have known for years about adding lime and/or alum to promote coagulation, but such materials result in much more sludge than even secondary treatment does. The polymer–ferric-chloride mix removes the same amount of suspended solids as secondary treatment—and produces only about 50 percent more sludge than conventional primary treatment. Although the advanced primary process eliminates less BOD than secondary treatment, that is of little consequence because of the large reaeration capacity of coastal waters.

Cost is a critical factor. Advanced primary treatment does away with the large capital expenditure needed to build a secondary treatment plant. Technicians simply add the polymers and ferric chloride directly to the sedimentation tanks of the primary treatment plant.

DIAGRAM: DEBORAH PERUGI DESIGN

FOR COASTAL CITIES, ADVANCED PRIMARY TREATMENT IS ENVIRONMENTALLY SOUND. IT ALSO ELIMINATES THE LARGE CAPITAL COSTS NEEDED FOR A SECONDARY TREATMENT PLANT.

Operation and maintenance expenses are about the same as for a secondary treatment plant.

A Tale of Two Cities

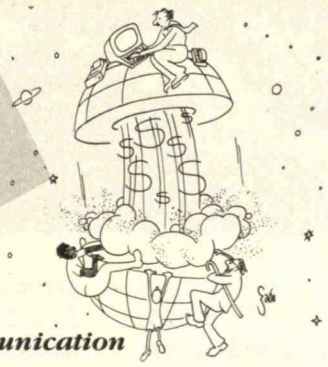
The use of polymers and ferric chloride could be an important element in the wastewater treatment procedures of coastal cities. It would allow some communities to divert billions of dollars going to secondary treatment facilities to more beneficial uses. Consider two cases: San Diego and Boston.

In 1981, EPA exempted San Diego from having to build secondary treatment facilities, and three years later the city began using advanced primary treatment at its Point Loma plant. But the agency subsequently noted a slight shift in the distribution of organisms that live on the ocean floor near the end of the plant's outfall pipe. Even though Paul Dayton, a reputable aquatic scientist at Scripps Institution of Oceanograhy, called this shift "utterly trivial," EPA took back its waiver in 1986 and ordered San Diego to construct a secondary treatment plant 30 percent larger than Point Loma. It also sued the city for not complying with the secondary treatment requirement.

Last May, a group of Scripps scientists called EPA's plan, which will cost San Diego about $1 billion, "a waste of money." Edward Goldberg, a chemical oceanography professor and 1989 winner of the prestigious Tyler Environmental Prize, dismissed EPA's waiver reversal. "Ecologically, there are no unacceptable adverse impacts as a consequence of the discharge off Point Loma," Goldberg said. "I am strongly opposed to the intent to provide secondary treatment of sanitary sewage for San Diego on econom-

The Information Gap

How Computers and Other New Communication Technologies Affect the Social Distribution of Power



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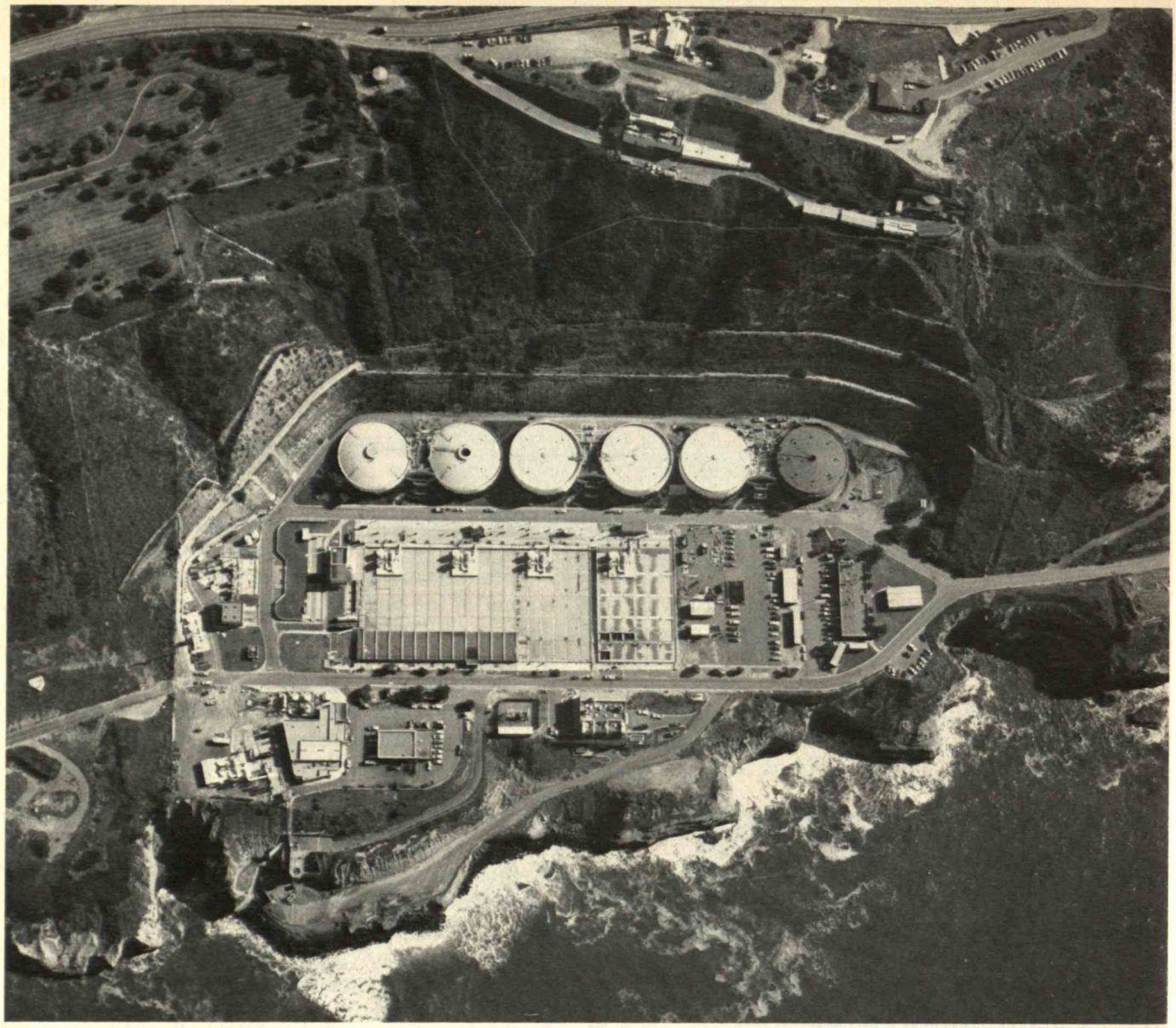
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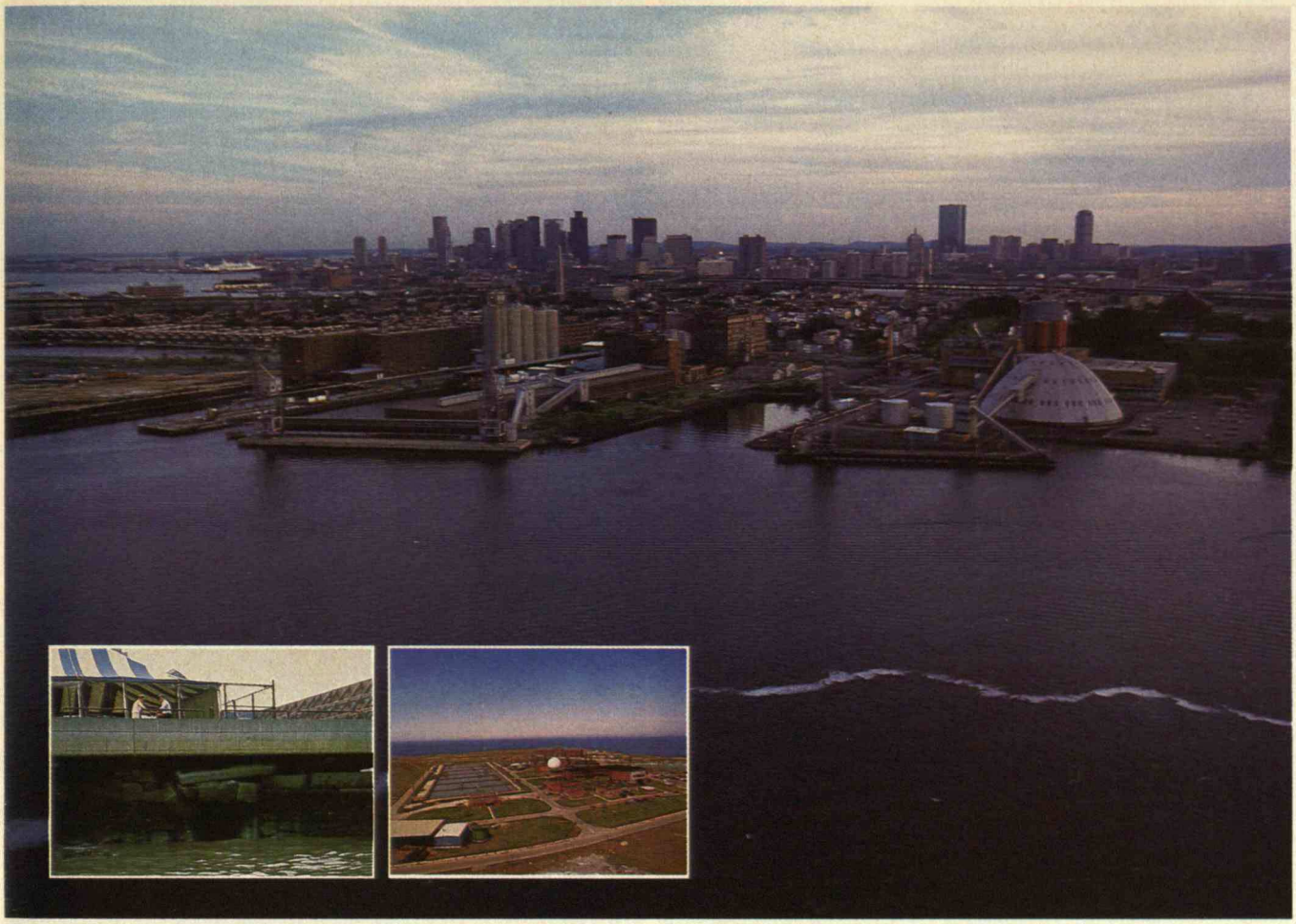


ic, scientific, and social grounds."

Based on this analysis, last fall San Diego's Metropolitan Sewer Task Force recommended that the city delay converting Point Loma to secondary treatment. (To recommend that the city not build a secondary treatment plant at all would be too much of a challenge to the Clean Water Act.) The task force decided that the plant should continue using the polymer process for 25 years and that the funds intended for implementing secondary treatment would go to construct a water reclamation plant. That could provide the additional treatment capacity EPA requires as well as water for city-wide irrigation. Nevertheless, in January of 1990, San Diego's city council caved in to EPA and agreed to go ahead with secondary treatment.

EPA's position on secondary treatment for the Boston area has been steadfast. In this case, the better buy for cleaning up Boston Harbor is a set of facilities to drastically reduce the discharge of raw sewage during storms. In the older parts of Boston, just one sewer system handles both sewage and storm water. During wet weather—about 60 times a year— the pipes in this system dump their contents, including raw sewage, directly into Boston Harbor at about 90 locations known as combined sewer overflows (CSOs). This dumping is responsible for the frequent closing of shellfishing and bathing areas.

In 1979 the Metropolitan District Commission, the agency in charge of Boston's water supply, proposed a new primary treatment plant and a nine-mile ocean outfall pipe and diffuser. It also applied for a secondary treatment waiver. The commission's rationale was that a high level of BOD removal by secondary treatment was not necessary. Dissolved oxygen is not a problem in the harbor, the commission argued, except where untreated wastewater from combined sewer pipes is dumped near the shoreline. The commission recognized that eliminating combined sewer overflows is



Opposite page: Local oceanographers disagree with EPA over whether San Diego should spend $1 billion for secondary treatment or continue to use advanced primary treatment at the Point Loma facility. This page: Constructing a secondary treatment plant won't solve Boston Harbor's pollution problem. Raw sewage enters the harbor during storms through about 90 "combined sewer overflows," one of which lies beneath the wharf at the New England Aquarium (insert far left). Facilities must be built to eliminate this discharge. Another wise move would be to use the advanced primary process at Boston's primary treatment plants (near left).

much more important than removing more BOD.

In early 1985, the state turned over the commission's wastewater responsibilities to a new agency, the Massachusetts Water Resources Authority (MWRA), and gave it a mandate to clean the harbor. EPA immediately sued MWRA for polluting the harbor and denied the secondary treatment waiver three months later.

MWRA did not attempt to appeal the waiver decision, which was scientifically flawed. (The Environmental Protection Agency had assumed such an unrealistic value for background dissolved oxygen that even the effluent from a secondary treatment plant would have violated standards.) Now MWRA is operating under a construction schedule ordered by a federal court that is designed to establish full secondary treatment by 1999. This $6 billion plan includes new primary and secondary treatment plants, sludge disposal facilities, and a nine-mile ocean outfall pipe and diffuser. The secondary treatment plant and associated sludge disposal facility represent about one-third of the total cost.

It will come as a rude shock to rate payers that such an expensive plan will not make Boston Harbor fishable or swimmable. Only reducing the inflow of raw sewage can do that. Moreover, while MWRA has accepted responsibility for the sewer overflow problem, the timing of building facilities to deal with it will not be resolved until after mid-1990. MWRA will stretch to the limit its financial and management ability to complete the other facilities by 1999. If the court-ordered schedule is followed, the facilities to control sewer overflow (estimated at another $2 billion) may not be finished until well into the next century.

Requiring secondary treatment for Boston Harbor makes no sense. In 1988 MWRA showed that if wastewater undergoes just primary treatment, the effluent issuing from the nine-mile outfall pipe will meet both federal and state water-quality standards. Poly-

PHOTOS: SAN DIEGO CLEAN WATER PROGRAM; SETH RESNICK, STOCK BOSTON; MWRA



The mussels in the polluted water on the left are hard to see. But the water could be cleaned.

mer treatment could be started as soon as the new primary plant is completed. This would remove as large an amount of suspended solids as secondary treatment. Moreover, the negative environmental impact of disposing of so much more sludge overwhelms any marginal benefit secondary treatment provides.

The harbor cleanup plan should follow the court-ordered schedule that calls for completing a new primary plant, an associated sludge disposal facility, an outfall pipe, and a diffuser by 1995. Some $2 billion would be saved by implementing advanced primary treatment and building CSO control facilities instead of going ahead with secondary treatment.

Resolving the Conflict

The central problem in both Boston and San Diego, as well as other coastal communities, is that uniform secondary treatment remains the law of the land. Procedures devised more than 10 years ago for granting exceptions to that law have proven unsatisfactory because the alternative at the time was conventional primary treatment. The appropriate approach now is to consider new and innovative treatment processes and then select the one best suited to the situation.

Congress needs to revise the Clean Water Act so that public agencies can do that. A good model might be the Clean Air Act revisions that the Bush administration proposed last August, which would let industry choose the technology to achieve air-quality standards. If the private sector may be allowed this level of decision making in protecting the environment, why can't public agencies do the same?

The National Research Council, the research arm of the National Academies of Science and Engineering, has agreed to study whether coastal cities could improve wastewater management. If its report, scheduled for 1992, indicates that Congress has offered too narrow a solution for cleaning wastewater, then there could be a strong impetus for legislative change. ■

PHOTOS: MWRA



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The End of History?

As we observe the decline of communism and ponder the meaning of this amazing development, I find myself brooding about "The End of History?"—a controversial essay by State Department official Francis Fukuyama in the Summer 1989 issue of the public-policy journal *The National Interest.* Although commentators have debated at length Fukuyama's political and philosophical statements, they have remained strangely silent about his attitudes toward technology. I find them nothing less than appalling.

The idea implicit in the article's provocative title is that because Marxism-Leninism is disappearing "as a living ideology of world historical significance," history as we have known it is coming to an end. Western democracy has prevailed. The once all-absorbing conflict with communism is concluded.

Although the triumph over totalitarianism is cause for celebration, Fukuyama is at the same time moved to melancholy. "The end of history will be a very sad time," he observes in a widely quoted passage. "The struggle for recognition, the willingness to risk one's life for a purely abstract goal, the worldwide ideological struggle that called forth daring, courage, imagination and idealism, will be replaced by economic calculation, the endless solving of technical problems, environmental concerns, and the satisfaction of sophisticated consumer demands." In short, we face the "prospect of centuries of boredom."

Fukuyama's critics have concentrated on his article's quotient of fantasy. Will not ideological disputes continue to flare up wherever people try to govern themselves? What exasperates me, however, is the author's gratuitous disparagement of engineering. In equating "the endless solving of technical problems" with "centuries of boredom," Fukuyama is voicing the age-old Platonic disdain for the technologist. This is both philosophically offensive and politically dangerous.

One would have thought we had passed the point of having to defend technology against the insults of self-anointed savants. Even if social and political problems were resolved—a farfetched conceit—science and engineering are by nature always on the edge of new frontiers. If the threat of boredom were ever to hang heavy over humanity, science and engineering—along with the arts—would provide the antidote. When it comes to ennui, Fukuyama has confused the remedy, creativity, with the affliction.



Strong technology is a prerequisite for human freedom.

Yet my argument goes beyond the philosophical question of what constitutes meaningful and gratifying human activity. If we nonchalantly dismiss technology as a minor factor in the scheme of things, we risk re-energizing those very forces of evil that for the moment are in decline. Once the euphoria of freedom has run its course in Eastern Europe (and eventually in China and elsewhere), the problem of how to order our lives politically and socially will quickly return to the fore. And here technology is not merely a peripheral factor to be considered casually by mandarin diplomats. It lies at the heart of the matter.

Freedom by itself is not what counts. People crave freedom of expression, but not if it comes with the freedom to starve, or even the freedom to struggle for subsistence while a few of one's neighbors enjoy great luxuries. Technology makes it possible to gratify the reasonable demands of most people on the planet. Yet technology must be effectively harnessed.

Communism has failed primarily because it has not provided a nourishing climate for technical progress. The East Germans crossing the Berlin Wall spoke less about freedom of speech than about the cornucopia of goods they saw displayed in the West. If successor governments fail to fulfill the hopes raised by technology, liberal democracy will once again find itself under attack from communist forces or, even worse, fascist demagogues.

How are science, engineering, and industry to be supported and improved? How are their fruits to be equitably distributed? What of technology transfer, technical education, environmental concerns, and turning swords into plowshares? These are the important questions to be addressed. Granted, ideology is also important. But divorced from technology or elevated above it, the best of political intentions can never be realized.

Among other duties, Fukuyama prepares "talking points" for the secretary of state's meetings with foreign leaders. It is frightening to think that his condescending ideas about "technical problems" might represent attitudes in high places. Unless the world's leaders recognize that strong technology is one of the necessary preconditions of freedom, we may find ourselves not bored by the end of history but dismayed at having to relive it. ■

SAMUEL C. FLORMAN, a civil engineer, is the author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, Blaming Technology, *and* The Civilized Engineer.

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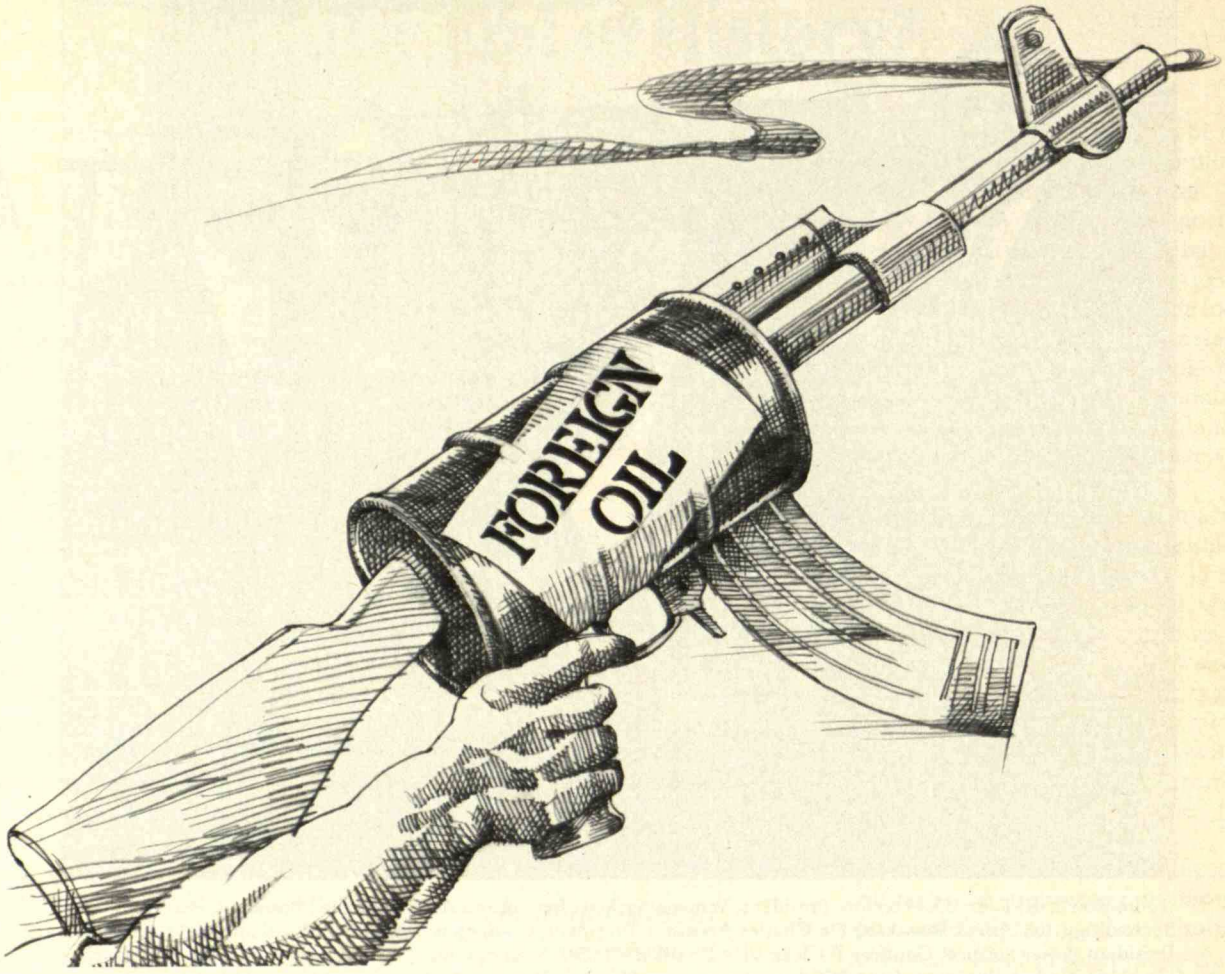


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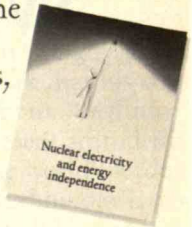
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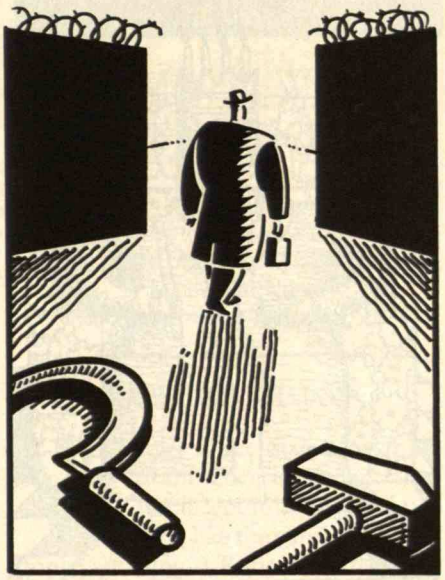
Eastern Europe's Economic Challenge

THE collapse of Eastern Europe's communist regimes, the most exciting political development of the last decade, may turn out to be the most important economic development of the next. The events symbolized by the dramatic dismantling of the Berlin Wall signal the entry of the Eastern European nations into the international system of trade, investment, and production. But a crucial question remains: on what terms? The answer will have far-reaching implications—not only for Eastern Europe but for the entire world.

Most Western economists and political leaders assume that a hard dose of austerity—tight monetary policy, high unemployment, and the drastic reduction of government subsidies—is necessary to make the region attractive to foreign lenders. Such a policy, proponents say, will force prices and wages to reflect more accurately the value of these nations' natural and human resources. This is the logic behind the recent economic plan proposed by the Solidarity government in Poland, which will probably entail the highest unemployment in Europe as long-subsidized, inefficient factories are shut down.

But whether or not austerity proves effective in the short term, too much of it would be disastrous in the long. If Eastern European governments try to attract foreign investment by permanently offering low wages and minimal labor standards, the result could be a chain reaction that would slow global economic growth and, ironically, hobble these nations' own ability to modernize.

This concern dominated a recent conference on global labor standards at the International Labour Office (ILO) in Geneva. European delegates worried that low-wage competitors to their east could hinder the next stage of European integration. The European Community (EC) appears to be gingerly approaching a consensus on labor standards for a united Europe. The idea is to adopt the system already found in West Germany, Austria, and the Scandinavian countries—a combination of high wages and benefits, widely available training opportunities, and a social contract between capital and labor that encourages technological progress. But if EC members are forced to compete with sharply lower wages and a deregulated business and labor environment in the East, policymakers might retreat from this emerging consensus.



The issue is not whether the nations of Eastern Europe will be integrated into the world economy, but how.

Delegates from the developing countries were even more pessimistic. According to one Indian economist, Eastern Europe's entry into the world economy means that poor countries now have no chance whatsoever to raise their standard of living while remaining competitive. Many Third World representatives at the ILO meeting believed that the only way to protect their place in the international division of labor would be to reduce wages and labor standards below their already low levels.

This could lead to a mutually disastrous international competition based on who can cheapen their labor the most. The only alternative, argued West German labor economist Werner Sengenberger, is to continue raising labor standards—both in the poorest countries of the world and in Eastern Europe. More expensive labor compels firms to invest in productivity-enhancing technology. And the prospect of long-run improvements in living standards encourages labor–management cooperation and worker commitment to learning new skills—two prerequisites for realizing the full potential of new production technologies.

The danger is that short-term austerity will make it extremely difficult for the new Eastern European governments to shift gears later on, when modernization rather than so-called structural adjustment should be the top priority. Thus these governments should insist from the beginning that aid and investment from the West go mainly to improving the technical skills of the workforce and to modernizing woefully out-of-date plants and technology.

Eastern European delegates to international organizations should endorse agreements to set minimum wages, monitor safety and health conditions, and guarantee the rights of freely elected trade unions. And in addition to seeking financial and technical assistance from Western governments and Japan, government leaders should draw on the experience of labor experts and public officials from neighboring countries already committed to such a social contract.

The real economic challenge for Eastern Europe is not simply to dismantle their centrally planned economies and enter the global market. It is to reconcile market forces with rising labor standards. ■

BENNETT HARRISON, a professor in MIT's Department of Urban Studies and Planning, is currently a visiting professor at Carnegie-Mellon University in Pittsburgh. His most recent book, coauthored with Barry Bluestone, is The Great U-Turn, *published by Basic Books.*

ILLUSTRATION: ROBIN JAREAUX

Reviews

CONFERENCE

DO MACHINES RULE US?

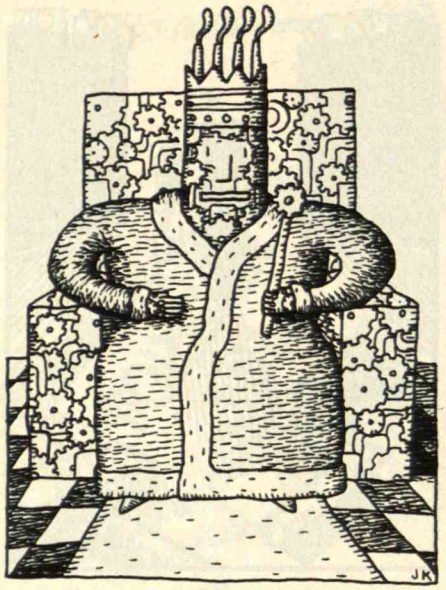
"Machines and History: The Question of Technological Determinism"
MIT, December 2 and 3, 1989

BY VICTOR K. McELHENY

BECAUSE people depend for their very lives on the complex systems of production and transportation that bring food, heat, light, and medicine, perhaps we can be forgiven for wondering whether we rule the machines or the machines rule us. The question of technological determinism—debated recently at MIT—hangs constantly over the inhabitants of a technological society.

The classical view, echoing Plato's notion of the ship's crew obeying the captain or the patient obeying the doctor, is that even though we make the machines, the machines rule us. Some resent the supposed reign of technology. Friedrich Engels wrote in his essay "On Authority" in 1872: "The automatic machinery of a big factory is much more despotic than the small capitalists who employ workers ever have been." Others are more sanguine. For much of the last 200 years, engineers and historians have tended to see all new technology as progress, and thus to view the history of technology as telling about the overthrow of irrational obstacles to progress.

Both attitudes assume that technology is an exogenous force, driving individuals and society as a whole. Faced with strong causal links like those between the spread of railroads in the mid nineteenth century and the emergence of industrial oligopolies, one can easily assign agency to the machines themselves, rather than to the cultures and polities that shaped them. Technology, by this view, is the history we could not escape. Technological determinism is shorthand for this complex of thought.



Despite its pervasiveness, the idea of technological determinism has not been the centerpiece of a meeting of historians in many years. And so Merritt Roe Smith of MIT's Program in Science, Technology, and Society, under the sponsorship of the Dibner Institute for the History of Science and Technology, organized the recent workshop "Machines and History: The Question of Technological Determinism." At MIT on December 2 and 3, 1989, some 30 participants from around the country vented profound discontent with the idea of technological determinism. They even came close to redefining the history of technology as the study of the social relations of technology.

A Change in Outlook

The field of technology history has been transformed in the 30 years since Melvin Kranzberg and others founded the Society for the History of Technology (SHOT), of which Smith is now president. Under the sway of technological determinism, historians of technology used to focus on particular devices and systems, and on brilliant individuals who led their development. While historians of economics and other subjects made lively connections between human thought and culture and the development and acceptance of new technology, historians of technology tended to neglect external forces. They paid little attention to economics, social and belief systems, or groups such as farmers or factory workers affected by (and affecting) technological change.

But most of the historians at the MIT conference reject the old approach to looking at technology. They want to examine the influence of politics—for example, on the routes and organization of transportation systems in the nineteenth century (Colleen Dunlavy, University of Wisconsin), and on the marketing of digital audio tape in the late twentieth century (Bruce Bimber, MIT). They study the tendency for social forces to lead to the abandonment of particular technologies, as when camels replaced wheeled transport in the Middle Eastern regions conquered by Muslim Arabs in the seventh century (Richard Bulliet, Columbia). They consider how a technology can affect different cultures in different ways. Personal computers, for example, might have their most revolutionary effect on countries like the Soviet Union that do not have a tradition of free exchange of information (Loren Graham, MIT and Harvard).

Underlying the historians' comments was a general impatience with a history that focuses only on leaders, whether political or cultural or scientific. Like the late French historian Fernand Braudel, they want to escape from a "history of events" toward a more explanatory history of common life. They insist on looking at groups of people once disregarded or viewed as passive objects, or victims, of technological change. They focus on topics such as the life of newly industrialized communities in the United States and Europe in the nineteenth century and in Asia today, and on the response of women to household technologies.

The conferees also expressed concern that the idea of technology as progress has led to needless suffering and danger, especially from weapons development in the twentieth century. Woven in with this is the anger of humanistic scholars

ILLUSTRATIONS: JAMES KACZMAN

at what they consider an amazing disdain among scientists and engineers for the humanists' culture of uncertainty.

A Tenacious Idea

Although it received a sound thrashing at the MIT workshop, technological determinism remains a powerful trend of thought. The development of new devices and systems sometimes appears to follow an internal rhythm of its own—unstoppable, revolutionary, and independent of outside social forces.

An example is the process that led to the development of the atomic bomb. It was no social influence that inspired Leo Szilard in 1933 to think of a sustained chain reaction. Rather, it was a statement in the press by the British physicist Lord Rutherford, who dismissed the idea of applying fission for power plants or weapons as "moonshine." The discovery of nuclear fission, in 1938, was made on a table top in Berlin. From there, the bomb grew largely out of calculations showing that an explosive of pure fissionable material would fit into a small package. Likewise, to most people, genetic engineering and computer chips look like arrivals from Mars. Even after 30 years of a history focused on the social relations of technology, technological determinism still has power.

One basic disappointment in the conference was the lack of dialogue between *historians* of technology and *practitioners* of technology. Few of the latter were present, and they expressed puzzlement at what they were hearing.

Louis Smullin, a professor of electrical engineering at MIT, said the discussion did not help him answer pressing questions of social policy for technology, such as the possibility of global climate change arising from human activity. He was asking for a "usable past" from the history of technology. The message seemed to be, "Engineer to historian: You've got our attention. Now talk to us." ■

VICTOR K. McELHENY is director of the Knight Science Journalism Fellowships in MIT's Program in Science, Technology, and Society.

BOOKS

THE (MEN'S) WORLD OF SCIENCE

The Mind Has No Sex? Women in the Origins of Modern Science
by Londa Schiebinger
Harvard University Press, $29.50

BY ROSALIND WILLIAMS

We are so accustomed to male dominance in science that we accept it as a fact of nature, like the sunrise. For example, sociologist Robert Merton's pioneering study of Britain's Royal Society, written in the 1930s, made much of the fact that 62 percent of the founding members were Puritan. He and other early sociologists and historians of science didn't think to mention that the Society and other 17th-century academies of science were all male.

Londa Schiebinger's admirable book reminds us that the general exclusion of women from science is not a fact of nature but a product of history. For Schiebinger, this male dominance demands a historical explanation. In *The Mind Has No Sex?* she provides one and shows how science and femininity came to evolve in different directions.

Books like this are often classified as "women's history," but the term limits our imagination. What is involved is not just the history of women but of everyone; and not just history, either, since patterns laid down in the past endure into the present. Schiebinger argues that science and femininity share a common past. They have been shaped by similar social, political, and economic forces, and they have been defined in contrast to each other. In particular, she shows how inseparable are the social and intellectual history of science. Men systematically excluded women from scientific institutions—and then used "scientific findings" to justify their exclusion.

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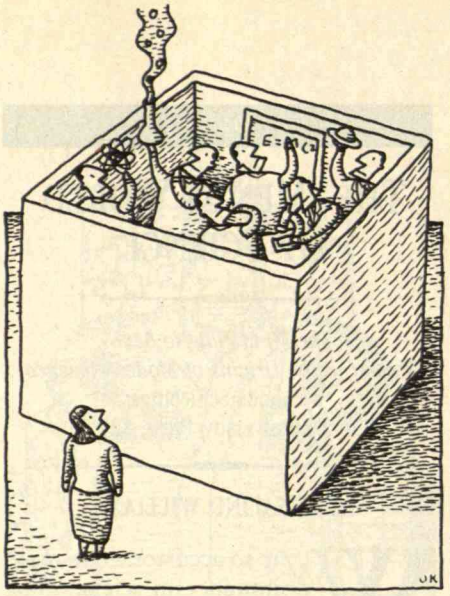
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Early in the Scientific Revolution, women played a subordinate but distinguished role in what was then known as natural philosophy. Noblewomen encouraged mathematical and philosophical discussions in their salons. Women from families of artisans helped build scientific instruments and make observations (between 1650 and 1710, 14 percent of all German astronomers were women). Schiebinger interweaves her general discussion with biographical essays on women like Maria Sibylla Merian, a leading eighteenth-century entomologist who traveled to Surinam to collect and draw insects, and Emilie du Châtelet, whose translation of Newton's *Principia mathematica* remains the standard French version.

That Madame du Châtelet is best known as the lover of Voltaire shows how gender restricted even these remarkably talented women. Most of them depended upon the mediation of powerful men like Voltaire or (in the case of artisanal families) of husbands and fathers who were eligible to join craft guilds.

For seventeenth-century women, participating in science was always a struggle. But by the nineteenth century, women had lost even this tenuous hold. The development of a capitalist market economy gradually eroded the economic power and cultural influence of noble and artisanal families alike. And the ascendancy of professional institutions—universities, learned societies, journals—diminished the role of scientific amateurs. Professionalization affected male and female amateurs alike, but the consequences were far more devastating for women because the professional paths were barred to them. Furthermore, science-related arts that women had traditionally dominated—midwifery, for example—were devalued, as matters such as childbirth became part of the medical profession and were redefined as the subject of new male-dominated academic fields.

Schiebinger also shows how, in a triumph for circular reasoning, the progressive exclusion of women from the practice of science was rationalized



by the content of science. In a case study both intriguing and depressing, she examines drawings of skeletons made between about 1730 and 1790, when the first drawings of distinctively female bone structure began to appear. In many of them, the sexual differences are exaggerated. The ribs are portrayed as narrow and confining, the skull as small, the pelvis as large. To our eyes, these drawings obviously distort female anatomy. In the eighteenth century, however, they were considered objective representations, solid empirical evidence that the female body was unfit for mental pursuits and most fit for childbearing.

The Limits of Scientific Hubris

Schiebinger's story is more like a Greek tragedy than a male conspiracy. From the beginning of the Scientific Revolution, the great ideal of scientific inquiry has been to purify itself—to create a completely reliable mode for understanding nature, uncontaminated by passion, language, or bias. But such hubris bears the seeds of its own downfall. The quest to exclude contaminating elements has also meant the exclusion of corrective elements.

Scientific inquiry is inherently a human enterprise, if for no other reason than because human beings decide what questions to ask. This was true for the male scientists of the late eighteenth century who chose to research the comparative anatomy of men and women. It is just as true for scientists today. Certainly, when historians several centuries from now look at the research agenda of twentieth-century science, they will see it laden with cultural values. The most obvious example is the way military missions have shaped scientific research; another is our investment in organ transplants, genetic engineering, and other complicated medical procedures as opposed to prenatal care, nutrition, and other forms of preventive medicine.

Now that women are slowly returning to science, perhaps these cultural biases will become more apparent and more subject to debate. But one should not be too optimistic. Even if the percentage of women in science is growing, the conditions of practice in the field are still dictated by patterns of male dominance. Take the model of the scientist who works long hours (even sleeping in the lab when the flow of research dictates) and who travels incessantly to international conferences. This model presupposes a domestic support system that is increasingly rare in this age of dual-income families. If we persist in defining scientific success the way we do now, many women (and a lot of men) will continue to be excluded from serious scientific careers.

That would be as great a loss to science as to the individuals involved. What women can bring to science is not another type of mind but a different set of life experiences, which in turn can raise different priorities, questions, and perspectives. In human societies, as in other ecologies, diversity breeds strength. When any social institution is controlled by a homogenous group, the result is an inherent bias beyond the power of individual goodwill or rationality to correct. When systematic exclusions are familiar enough, we cease to notice them, as they seem part of the natural order of things. The value of Schiebinger's book—and of "women's history" in general—is that it reminds us how arbitrary and artificial gender relationships are, and suggests that they

could be as different in the future as they have been in the past. ■

ROSALIND WILLIAMS is an assistant professor in the MIT Writing Program and the author of Notes on the Underground: An Essay on Technology, Society, and the Imagination *(The MIT Press, 1990).*

BOOKS

THE GOLEM AND THE COMPUTER

Books by Primo Levi
recently published in the United States:

The Periodic Table
Schocken Books, $16.95/$7.95

The Monkey's Wrench
Summit Books, $15.95

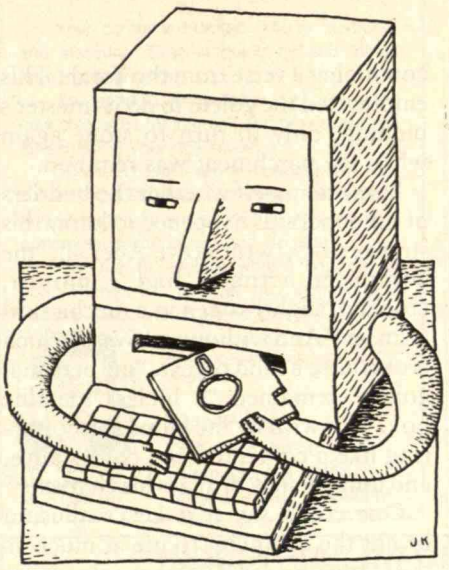
Other People's Trades
Summit Books, $18.95/$8.95

The Mirror Maker: Stories and Essays
Schocken Books, $16.95

BY WILL WARNER

IT'S been 30 years since C.P. Snow described the gap between the "two cultures" of science and literature, and today the gap is wider than ever. The demands of increased specialization leave little time for a scientist to savor the plums of literature, or for an artist to contemplate even the most important and interesting questions of science. Still, it is not too difficult to persuade a scientist of the value of liberal arts. It is usually much harder to show an artist the beauty and elegance of science. That is why it is such a pleasure to read writers like Primo Levi.

Levi, an Italian, is probably best known for his books chronicling his experience during World War II as an inmate of the Auschwitz concentration camp. Indeed, he became a symbol of stubborn integrity and hope in the face of the worst that humanity has to offer—an image that was shaken somewhat by his suicide in 1987.



But in the years just before and since his death, we have come to know another Levi: the scientist-writer who spoke across the gap between the two cultures; the chemist by training who belonged to what he called that "austere generation of humanists who still insist on wanting to understand the world around them."

Since 1984, U.S. publishers have issued translations of one novel and three collections of essays (the most recent in December 1989) that display Levi's unrestricted curiosity and natural way of uniting the two cultures. They are filled with evidence of the insight and enrichment that come with an appreciation of science as an empowering human enterprise.

Levi was not a popularizer of science like Carl Sagan, or a "great explainer" like Isaac Asimov. More like Jacob Bronowski, he was a scientist whose experience in life and concern for humanity drew him into a larger world. From a bridge of his own construction between art and science, he wrote with warmth, gentle humor, and quiet, unassuming erudition—and a touch of sadness. "I have enjoyed looking at the world from unusual angles," he wrote, "examining matters of technique with an eye of a literary man, and literature with the eye of a technician."

This double vision shaped how Levi experienced and described the world. He saw the science in everything. In an essay in *Other People's Trades* (1989), he explores the many ways a butterfly is beautiful. It is not just its symmetry and color, gay lilting flight, or role in myth and lore that pleases Levi. It is the butterfly's physics, "its splendid metallic and iridescent effects" produced "by exploiting the effects of interference we observe in soap bubbles." For Levi, the butterfly's metamorphosis is both fascinating biology and heaven-sent literary metaphor.

In addition to seeing the science in the most poetic of images, Levi also had a special sensivitity to the poetry inherent in scientific inquiry. He enjoyed presenting a chemical-engineering problem as a detective story. In one essay in *The Periodic Table* (1984), he tries to discover why paint is turning to mud in the can. One story in the novel *The Monkey's Wrench* (1986) concerns a certain enamel and its failure to withstand anchovies. Levi captures the way the chemist, challenged by such problems, applies the scientific method—a cycle of observation, hypothesis, and experiment converging on the "truth." In the process, the reader comes to see how this is the path to knowledge not only for scientists but for others as well—police detectives, computer programmers, historians, appliance repair people, even literary critics.

The Rigger-Chemist

To help convey the romance of science, Levi would derive the abstract from the concrete. In *The Monkey's Wrench,* he relates the experiences and world view of one Libertino Faussonne, a master rigger who travels the world erecting bridges, radio towers, cranes, and drilling derricks. In his working-class vocabulary and with many revealing asides, Faussonne describes his love of his work. Near the end of the book, the chemist-narrator begins to speak. His vocabulary and asides are different, but he tells the same story. He calls himself a rigger-chemist. He too erects structures, surpassingly tiny structures built from molecules. In this way, Levi uses

the concrete world of bridges and cranes as an extended metaphor for the more abstract world of chemistry—the manipulation of the invisible. The result is a paean to the pleasures of technical work.

Perhaps the best example of Levi's approach to merging the worlds of science and literature is a piece from *Other People's Trades* called, revealingly, "The Scribe." Levi recounts how his new personal computer brings to mind the Eastern European Jewish tale of the golem.

Centuries ago, he explains, a "magician-rabbi" created a clay automaton known as a golem, and endowed it with superhuman strength and blind obedience. He hoped that the golem would defend the Jews of Prague from the pogroms. But the creature remained inanimate—until its maker placed in its mouth a roll of parchment containing a verse from the Torah. This empowered the golem to do its master's bidding, only to turn to stone again when the parchment was removed.

"I asked myself whether the builders of my apparatus happened to know this strange story," writes Levi. After all, "the computer actually had a mouth, crooked, slightly open in a mechanical grimace." And without software, which is of course a kind of text, "my personal golem" remained "a lifeless metallic box." But with it, "he hums softly, purring like a contented cat, comes alive, and immediately displays his character."

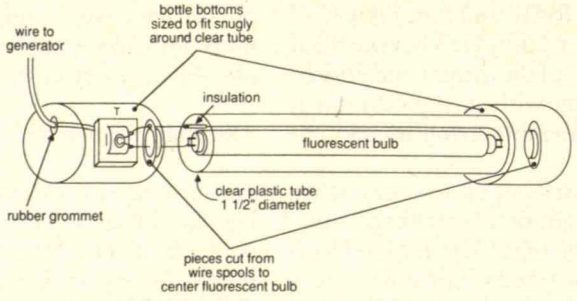
One could say that Levi's allusion brings the computer to life as much as the software does. His story takes what might at first seem a lifeless technology and makes it into an ironic comment on the power of writing.

Carl Sagan once wrote that the Bible is innocent of electromagnetism. Perhaps that is no great defect, but a unified intellect is rewarded by the little pleasures of allusion across the two cultures provided by Levi, and others too. Tolstoy, for example, calls individual human tendencies the "differential" of history; only through "integration" of these differentials can we hope to understand the laws of history. One critic calls this passage obscure, but to a reader with a little calculus it is clear and may even impart a spine-tingling insight.

Conversely, failing to speak to both cultures diminishes both and has serious practical consequences. Much writing about science for nonscientists is awkward and protracted, because it does not challenge the intellectual schism. Worse, it oversimplifies the world. Without recourse to mathematics, for example, popular explanations of special relativity run to more than a hundred pages and still leave readers

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with vague ideas about contracting rods and slowing clocks. One simple algebraic expression (the formula for an interval in space-time) would answer their questions, but it is deemed to be, and probably is, beyond the ken of most people.

Sadly, at the root of the problem may be a misunderstanding. Some nonscientists criticize science as merely a collection of facts with no "narrative tension" and nothing to excite the imagination. But the charge is false. Great scientific theories are creative achievements designed precisely to replace individual facts. Like great novels, they aim to unify experience, to express a reality sometimes too subtle and sometimes too obvious to be stated flatly.

When he coined the term the "two cultures," Snow proposed knowledge of the second law of thermodynamics as a test of scientific literacy, equating it to a knowledge of Shakespeare. It was a good choice. The second law is an idea of great power and scope and subtlety. The law tells us that decay is the only thing that happens spontaneously. To progress, or just to retard decay, requires labor of some kind, and all labor is opposed by friction of some kind. Perfect efficiency and perpetual motion are impossible.

Here is the essential, immutable hostility of the universe: decay and friction, the cosmic "death and taxes." Shelters weather and collapse, stomachs empty, food rots. If the universe did not enforce this law, animals would not eat one another, and there would be no war. All this is contained in the intellectual creation called, simply, the second law.

If in the end Primo Levi succumbed to this hostility of the universe, all the more reason to value the remarkable work he produced in his lifetime. His writing proved that any division of intellectual life is artificial, that the world is one. Indeed, modern physics is actually a branch of philosophy. And mathematics, the language of science, is a form of poetry. ■

WILL WARNER is a computer engineer and writer in Ann Arbor, Mich.

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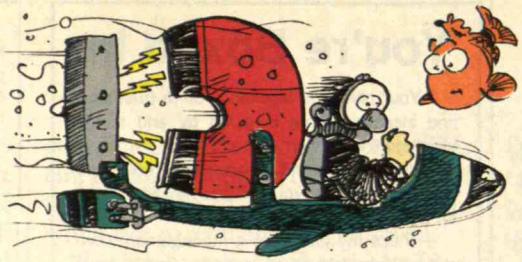
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Wasteful Use

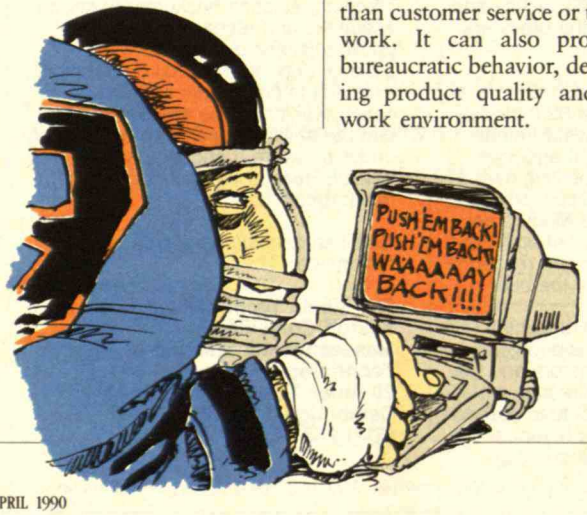
With a projected price tag of $72 billion, the B-2 stealth bomber—"an obsolete penetrating bomber for fighting a nuclear war with the Soviet Union"—tops the Center for Defense Information's list of wasteful weapons. The center used a number of criteria to come up with its list, including whether weapons were built for obsolete or unachievable military goals.

After the B-2, the Washington-based think tank panned the Midgetman ICBM at $28 billion: "With 12,000 strategic weapons, the U.S. does not need a new expensive missile." Third on the dishonor roll was the $23.4 billion MX program—another "intercontinental ballistic missile for fighting a war with the Soviet Union."

Useful Waste

The wastewater from Iron Bridge sewage plant in Orlando, Fla., is providing the raw material for a new wilderness park, reports *Environmental Action* magazine. After reviewing 21 options, Orlando officials decided that creating a wetland to act as a natural filtration system would cost relatively little and also be favorably received by the public.

Piped to the park, wastewater filters through a 420-acre wet prairie of cattails and bulrushes, a 380-acre mixed marsh, and a 400-acre wood swamp. In all, the park contains more than 2 million new aquatic plants and trees.



Computer Plus?

Alfred University computer scientist Gary Hasman's computerized "assistant football coach" can analyze a game situation and suggest the best of several plays. Still in the prototype stage, it operates fast enough to work during a game. Initially intended for high school teams, the software could soon be so sophisticated that it could aid professionals, Hasman says.

Computer Minus?

On a more pessimistic note, Rebecca Grant, who teaches information systems at the University of Cincinnati, has found that computers may be no better than human overseers when it comes to monitoring workers. Now common in the insurance, banking, and airline industries, computer monitoring can convey the impression that production counts more than customer service or teamwork. It can also promote bureaucratic behavior, degrading product quality and the work environment.

Superboat

A revolutionary propulsion system for marine vessels could result from tests at Argonne National Laboratory. Argonne's Michael Petrick says that magnetohydrodynamic (MHD) propulsion promises to eliminate all moving parts of a boat or submarine drive system, including propellers and motors.

The Defense Department is funding the $4 million project because MHD-powered craft should be quieter and harder to detect. On the civilian side, "MHD technology could lead to large cargo submarines for safe, efficient shipping," Petrick says. And quieter marine-research vessels would be less disruptive to undersea life.

In the system, electrical current passes across seawater inside a duct that is surrounded by a superconducting magnet. The magnetic field and the current interact to create a forc that pushes seawater out of the duct, propelling the ship.

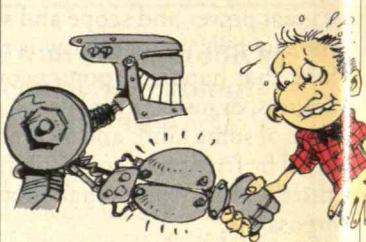
Rocks of Ages

Rocks from northwestern Canada have been dated at 3.96 billion years, making them the most ancient ones discovered on earth by over 100 million years. Collected by Washington University geologist Samuel Bowring, the samples narrow to 600 million years the gap between the earth's birth and the first preserved rocks.

In his St. Louis lab, Bowring extracted the mineral zircon from the rocks, which enabled him to date them at over 3.84 billion years. But, he says, the rocks "showed evidence for more than one period of growth, which obscured their original age." So he went to the Australian National University to use SHRIMP (sensitive high mass-resolution ion microprobe), which can date as little as two billionths of a gram of zircon to within a few million years.

Robot Muscle

Shaking hands with a robot may become a bit less painful, thanks to Japanese researchers who are developing artificial muscles for mechanical devices. According to Yoshithito Osada, a chemist at Ibaraki University, soft polymer gels contract when electricity is applied and expand when the current is turned off. This gives them muscle-like qualities so that devices incorporating them can raise and lower loads.



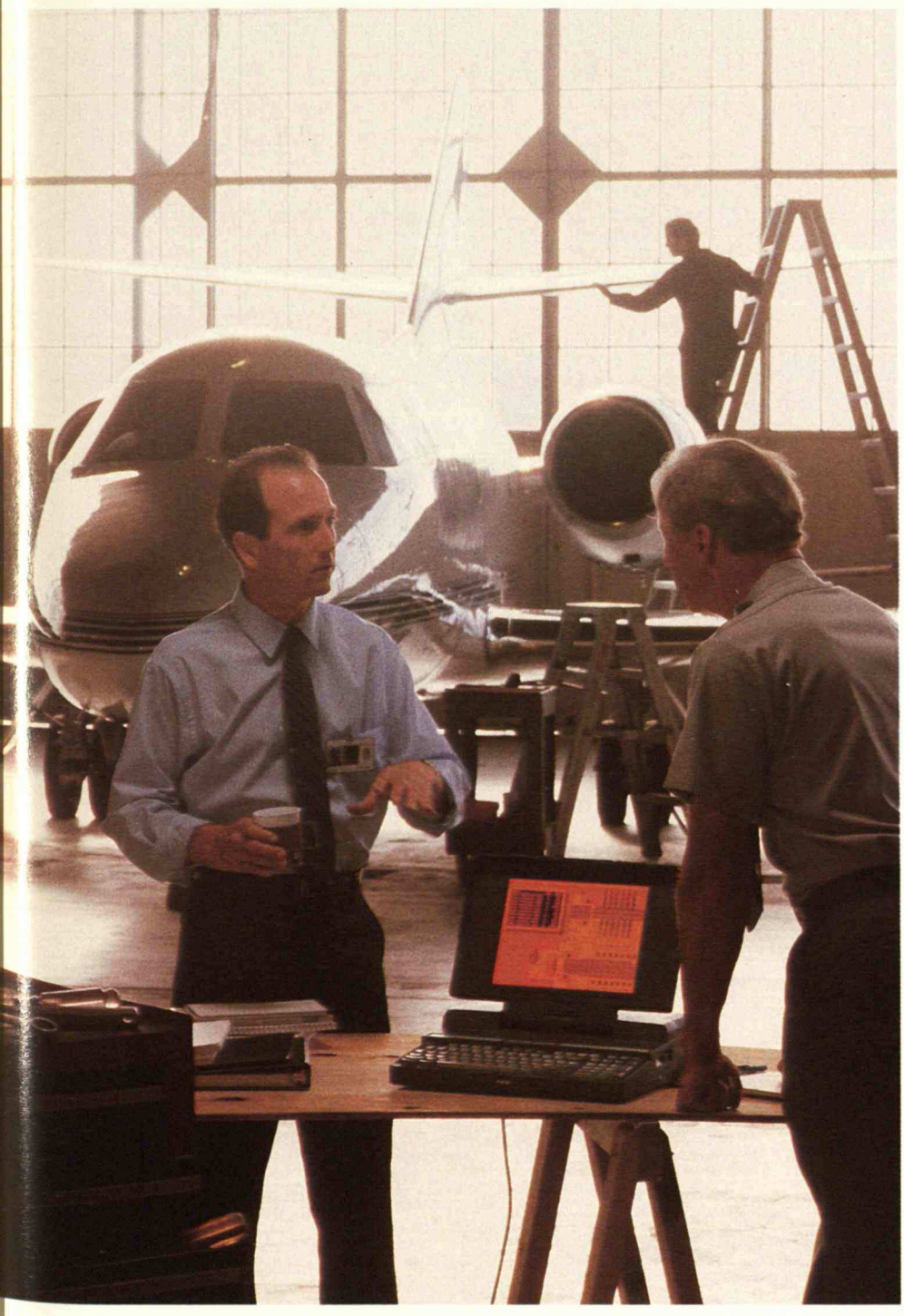
"Actuators for robots made of these soft gels will behave more safely, more carefully, and more gently," says Osada. "They will not tear out the knob when they open a door, and they will shake hands softly instead of crushing a hand."

Copylefts

The Cambridge-based Free Software Foundation (FSF) protects its products with what it calls "copylefts." A copyleft lets others copy a program—as long as they pass on that freedom to others. Typical software companies copyright their products to take away this liberty.

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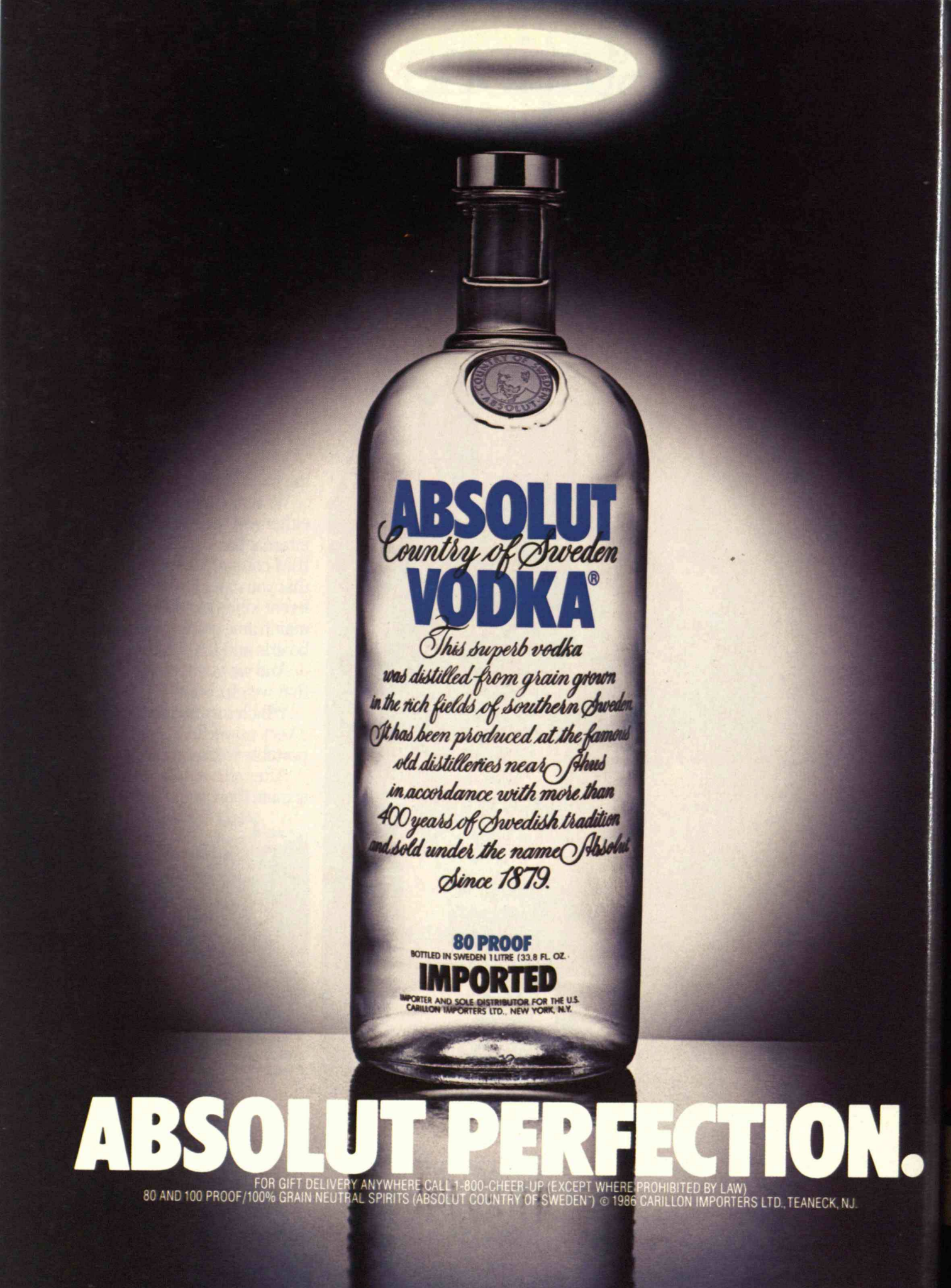
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